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Contents

	PAGE
The Night Watchman	263
Cast Crankshafts	263
Non-Ferrous Scrap Supplies More Plentiful	264
Prime Mover Reconditioning	264
Random Shots	264
High-Duty Alloy Cast Iron	265
Turning Cast-Iron Borings to Profitable Account	268
Catalogue Received	268
Runners and Risers for Grey Iron Castings	269
Small Steel Furnaces	273
Vitreous Enamelling Section—	
Heat-Resisting Muffle Equipment	274
Costing in the Vitreous Enamelling Industry	276
Growth of Cast Iron	278
Company Meeting Report—	
General Refractories, Limited	279
The Week's News in Brief	282
Trade Talk	282
Contracts Open	282
New Companies	282
Personal	282
Obituary	282
Forthcoming Events	282
Raw Material Markets	284
Company Reports	284

The Night Watchman

It has been customary in British industrial circles to consider the post of night watchman as something of a sinecure. Usually it is a position reserved for a partially disabled ex-soldier or a workman who otherwise would be drawing heavy compensation for an industrial accident. Yet any intelligent analysis of his duties—and such a study has been printed by our American contemporary, the "Iron Age"—immediately shows that, in addition to taking charge of valuable property, he has to direct his attention to (1) the prevention of fire; (2) the avoidance of waste; and (3) make his contribution to the safety-first aspect of the works. Fire prevention is obviously one of his major activities, and he should be familiar with the operation of the various systems available, such as the automatic sprinklers, the extinguishers, the position of the hydrants, and so forth. He should have his attention called to coal, coal dust, oily rags—especially linseed—cotton waste, metallic powders and varnishes, as any of these are liable to spontaneous combustion. If smoking be allowed in any shops, it should—during the last half-hour or so of the working period—be vetoed, in order that stub ends may burn themselves out before the shop is closed down. Under the heading of waste, the night watchman can make a serious contribution towards the payment of his wages by turning off taps, reporting leaking roofs and air lines, extinguishing lights, closing windows and doors, switching off motors, and doing all possible to stop robbery and vandalism. His contribution to the prevention of accidents is mainly by reporting dangerous obstructions, unfenced holes, and obvious electrical hazards. He should each night make a log for presentation to the works manager, to whom he should be directly responsible. His log should bear his name and the date. The first column should carry the caption, "Tour"; the second, "Condition"; and the third (to be filled in later by the works manager), "Action taken." Typical entries would read, say, "6 to 7: sand riddle motor left running; shop foreman notified"; or, "2 to 3: roof leaking in corner of core shop; repaired"; or, again, "3 to 4: rats prevalent near stores; ratcatcher sent for."

From the above, it is quite clear that the night watchman's job is not to be dismissed as being a sinecure for a worthy pensioner, but a position demanding the intelligence of a detective, a knowledge of the technique of fire prevention, whilst his integrity must be beyond question. Moreover, he must be imbued with the spirit of safety-first and be aware of the cumulative effect of waste emanating from no matter what source. Actually, he is better placed than the bulk of the employees to combat this, as during the bustle and noise of day-time operation, leaking compressed air lines are not noticed, but the minute operations stop and before the effect of the compressor has ceased to be felt, it becomes perfectly obvious. Gas leakages, too, are more easily detected in a still shop, whilst our experience is that a fair percentage of the population is incapable of turning off running water completely. Where night shifts are prevalent, it is quite usual for some shops to be unoccupied, and in such circumstances these departments should be visited by a reliable employee several times during the night and a report made. We remember a day-operated steel foundry attached to one of Britain's largest iron and steel works, obviously working a night-shift in most departments, being raided by a gang of lads and about a hundred pounds' worth of crucibles were smashed. Yet there would be many hundreds of employees working in other sections of the works. In times of national emergency, duties other than those we have enumerated may fall upon the night watchman, and for many hours a day he may have to act as liaison officer with the military and police authorities, and any neglect may involve a firm in serious consequences.

Cast Crankshafts

The Paper recently presented to the Institution of Automobile Engineers by Dr. Gough and Mr. Pollard, of the National Physical Laboratory, contains a vast amount of data on cast crankshaft materials which is probably unique at the present stage of development. The materials were all supplied through the British Cast Iron Research Association, and were five in number, covering in stages the range between cast steel and a nickel chrome cast iron of about 19 tons per sq. in. tensile. The cast steel itself contained alloy additions. The next material was the borderline material between steel and iron containing copper and chromium, the third was an inoculated alloy iron containing molybdenum, the fourth a specially melted molybdenum chrome iron and the fifth the nickel-chrome iron cupola-melted. The range of tests was very wide, covering not only the usual analytical and microscopic tests, but also complete mechanical tests, both static and dynamic or fatigue tests. The special feature of the Paper,

(*Concluded on page* 264.)

Non-Ferrous Scrap Supplies More Plentiful

By "Onlooker."

The extremely rapid rise in the values of new metals took the scrap dealers just as much by surprise as it did everyone else, but it did not take them long to realise that an excellent chance was offered to make good profits through an unparalleled appreciation in the prices of virgin metals. That they realised this ambition to the full is doubtful, for they were not the only people to grasp the inwardness of the rocketing markets in Whittington Avenue, and they very quickly discovered that the primary holders of old metals were not in any hurry to part with their material. During February and March it was only those consumers bold enough to bid over the immediate value who were successful in obtaining anything like a good tonnage, for, as usually happens on these occasions, the people who have material to sell hold on stubbornly in the hope that they will sell it all out at the top price. They never do, of course, but that does not prevent them from repeatedly trying to do what nobody has ever achieved yet.

Continental Buying

With business running as briskly as it is, there must obviously be more process scrap available, but it does not follow that this is going to find its way on to the market for sale and use in the foundries. Manufacturers nowadays manage to use up a good deal of this kind of material themselves, and there is also a demand from the Continent which has the effect of keeping this country rather short of supplies. This Continental buying is, it is true, rather erratic, but when inquiries are circulating, then good prices are paid, and people here with scrap to dispose of are certainly not to be blamed if they take advantage of favourable opportunities to dispose of their holdings. Later it may even be necessary for the Government to prohibit export of non-ferrous scrap, but that time has not come yet, and perhaps it never will. For the most part, users of scrap rely upon the disposals made by the big public works contractors, Post Office, railway companies and shipbreakers, while additional supplies come from the Arsenal sales and dockyard disposals. These sources can only yield a certain amount, and, generally speaking, competition is very keen, but eventually the scrap does find its way into the foundries for conversion into a variety of different articles. The semi-famine in scrap supplies is certainly a thing of the past, and from now on the position ought to be easier both in brass and copper.

Cast Crankshafts

(*Concluded from page* 263.)

however, is the result of tests on these materials under combined stress, in this case bending and torsion such as an ordinary crankshaft has to withstand. By means of a machine previously described it was possible to submit every specimen to a predetermined combination of these stresses in fatigue. The results indicate that any combination of these stresses between pure bending (no torsion) and pure torsion (no bending) can be forecast from the tests in bending and torsion taken separately. The object of the Paper was not to determine whether the materials were in fact suitable for crankshafts. The majority are already in successful use and the remainder are under active development. The aim was to assist the designer to choose a material from the range available to suit the stress conditions he has to meet. Clearly a stationary engine is less troublesome to deal with than that for a moving vehicle, and, for example, a diesel engine is a more difficult case than a petrol engine. All will find a place. The problem is to assist the designer in finding the most economical material to serve the purpose in view, and the contribution made by this Paper is a credit to all concerned.

Prime Mover Reconditioning

Whilst foundry executives are undertaking such extensive additions and alterations to their shops, it is a matter of some interest to them that there has recently been created new works near Wembley for the express purpose of rebuilding prime movers such as oil, gas and steam engines. The firm in question, the Kessel (Power Plant), Limited, have built at Heather Park Drive, Wembley, Middlesex, a shop 170 ft. long by 60 ft. wide, served by a siding from the Euston main line. It is spanned by a 15-ton electric overhead travelling crane, so that the handling of the engines, their dismantling and re-erection can be effected in the same manner as in the builders' erecting shops. The shop illustrated in Fig. 1 is excellently lit by Benjamin lamps, designed to give a general illumination of 10 ft.-candles. Along the east bay, there is a suite of general, private and drawing offices; the last, as it also serves a room for the works manager, affords from its continuous window a clear view of the whole works. Next to it, in

Fig. 1.—A View in the New Works of Kessel (Power Plant), Limited.

the same bay, at the north end, is the machine shop replete with drills, an s.s.s. lathe with 5 ft. 6 in. centres, and a Herbert turret lathe. There are, in addition, grinders and the usual machine-shop tools. This end of the shop is laid out as a testing bed, so designed as to test the efficiency of either gas or oil engines running at full load, whilst it is proposed to install a boiler for the provision of steam. A 6-in. gas main and oil tanks are already in service. Engines up to 1,000 h.p. have already been rebuilt and tested.

The claim is made that not only can an obsolete engine be reconditioned but also modernised, and, in any case, all worn parts, such as cylinders and bearings, are renewed. The engine is thoroughly tested before dispatch and is done so under the supervision of Lloyds inspectors. The engine is then dismantled and re-erected at the works of purchasers by the firm's own engineering staff.

In addition to prime movers, the work undertaken also includes compressors—a factor also of real interest at the moment.

The service given by this firm should be particularly useful at a time when the delivery of new plant is becoming more and more difficult.

Hurst, Nelson & Company, Limited, Motherwell, have received orders for eleven petrol carrying tank-wagons and nine fuel-oil tank-wagons for the Rhodesian railways.

Random Shots

A very learned correspondent, whose grey matter must have an exceedingly high specific gravity, sends in the following contribution:—"New applications for such elements as tungsten and molybdenum are being developed almost daily. According to a recent message in the 'Times,' about 100 'sit down' strikers in two metallurgical works at Waukegan (Ill., U.S.A.) met force with force when 120 policemen and deputy sheriffs tried to carry out a Court order for their eviction and arrest. Attacked with tear gas bombs, they sprayed their assailants with acid from fire extinguishers and hurled at them bottles of tungsten and tantalum valued at 500 dollars each, together with steel weights and fragments of molybdenum.

"The metallurgical value of these metallic elements in defence tactics may have been linked up with their specific gravities. The 'mv^2' of fragments of molybdenum, tungsten and tantalum (specific gravities 10.0, 18.8 and 16.6) were probably calculated to lay out the most stalwart bobby. A 'sit down' strike in the Treasury is probably the dearest wish of an ambitious deputy sheriff, for gold has a specific gravity of 19.32."

* * *

It is strange what a diversity of appeal there can be in the printed paragraph Our correspondent sees a metallurgical joke, as it were, in an account of a strike, whilst "Marksman" invariably gets a good laugh out of any metallurgical treatise that he reads.

Take, for instance, the announcement of a paper on "the damage done to lead-sheathed cables by caterpillars." This conjures up a picture of an extensive diet campaign amongst these lowly creatures, resulting in the slogan, "Eat more lead." Of course, the whole affair might easily be a mere cock and bull story on the part of some ingenious engineer looking for an excuse for bad workmanship, on a par with the one frequently told about the radio set. Whenever this goes wrong, it is always due to a spider's web in the works. On the other hand, there might be something in it, for it is well known that bats can do a great deal of harm in the belfry, and that bees in the bonnet are an intolerable nuisance. So why not caterpillars in the cables?

* * *

Easter is over once more, and those who put their shirt on "Royal Mail" will be able to dispense the spondulicks at Brighton or Blackpool and engage in a little "sand handling" with the children. Those who backed a loser had to be content to attend to their "blooms" and "runners" in the garden.

* * *

"Alas for a misused boyhood, during whose years I might learn nothing whatever—of pond-hap which matters the save interest me—most commonly things not mattering very much," states an evening paper. Most people will agree with him. Since the war everything learnt at school does seem upside down.

Another of our daily papers complains that there is far too much time and money spent on costing in industry these days. The Costing Sub-Committee should note this next time they hold a meeting on board a yacht, and leave their reports in the club house.

* * *

There are a few people who would like to know who the young lady was who defied all rules and accompanied the London Branch on their trip to Belgium.

"Marksman."

High Duty Alloy Cast Iron*

By Dr. A. B. EVEREST

In dealing with the subject of high duty alloy cast iron it is in the first place necessary to define what is meant by the term "high duty"; it is evident that already there is considerable confusion of thought on this subject, and it appears necessary to work out some official definition before the term becomes misused as was the case in connection with "semi-steel." It is not easy to define high duty cast iron, but after thinking over the matter the author submits the following as a basis of further discussion. "High duty cast iron is cast iron specially made to meet particularly severe conditions of service where under similar circumstances ordinary cast iron would fail." The author would like to make it quite clear that under this definition he would not consider as high duty, ordinary or engineering grades of cast iron which have been improved by small alloy additions, and irons in this class are therefore not discussed in the present Paper. Ample reference has been made to them elsewhere. In this Paper it is, however, proposed to consider those special irons containing smaller or larger alloy additions which are made mostly by special processes on account of which outstanding properties in one direction or another have been developed.

Where Ordinary Cast Iron Fails

In view of the above definition it is felt that a useful approach to the subject of high-duty cast iron can be made by considering the conditions under which ordinary cast iron fails or is inadequate. These conditions can be summarised under approximately four heads, namely, lack of strength and toughness, lack of wearing quality, lack of corrosion resistance and lack of heat resistance. Little enlargement is necessary on these heads beyond emphasising the fact that whilst it is recognised that cast iron may fail under these different conditions its wearing quality and corrosion and heat resistance are initially of quite a good order and are often superior to many of the more expensive metals and alloys. It is, however, especially to meet conditions where ordinary cast iron is inadequate under these different heads that the modern high duty cast irons have been developed.

In view of the reference above to the directions in which ordinary cast iron may prove insufficient for a particular job it is hardly necessary to say that the types of high duty cast irons which are of outstanding interest to-day are those with specially high strength, toughness and fatigue resistance, those with specially high hardness or other qualities to give superior resistance to wear, and those which have been developed especially for their corrosion- and heat-resistance.

The Production of High Duty Alloy Cast Iron

In the production of high duty alloy cast irons of these different types three considerations are essential. In the first place a base-iron must be prepared under conditions of careful control. In the second place, alloy additions must be made at some suitable stage in the preparation of the iron and in the third place consideration must be given to the after-treatment of the casting for the development of the optimum properties. In the production of certain types of high-duty iron, particularly those containing high proportions of alloys, the preparation of the base-iron is very often combined with the alloy addition, the addition being all or in major part made with the furnace charge.

Enlarging on the points mentioned above, the preparation of a base iron under controlled conditions and with a controlled analysis depends primarily on the selection of suitable grades of raw materials, and, secondly, on the efficient control over the melting operation. In the production of high duty irons, particularly those for high strength and wearing quality, large proportions of steel scrap are almost invariably included in the charge in order especially to control and reduce the carbon content. The selection of suitable raw materials, however, is useless without the necessary control over the melting operations. Melting is frequently carried out in the ordinary cupola furnace, and it must be emphasised that, given proper control, the cupola is one of the most suitable means for the preparation of the base iron. Cupola control depends perhaps more on having a correct design, using good quality coke and on properly balancing the coke ratio and air blast so as to obtain efficient and hot melting than on any special refinements in arrangements of tuyeres or other details of the cupola structure.

Other types of melting furnace offer special advantages in the preparation of the base-iron, and this applies particularly in the case of the air-furnace or in the case of the electric furnace. In this country to-day it can be said that the largest castings in high-duty iron are made from the cupola. Some of the intermediate sized castings are made from the air-furnace, whilst the electric furnace is used only for the production of specialised products on a relatively small scale. In the United States, however, larger sizes of electric furnace are in frequent use, and are used for the production of high-duty cast iron frequently in the duplexing process in which the bulk of the charge is first melted in a cupola, and is then tapped into the electric furnace for refining. Super-heating is valuable in the production of high duty irons, particularly on account of the high pouring temperatures generally required, and furnaces of the above type should be operated under conditions to give maximum possible temperature.

The method of adding the alloys depends largely on the particular material being added and on the result it is required to obtain. With highly alloyed irons, such as "Ni-Resist" and Nicrosilal, it is customary to add the alloys with the furnace charge or in the furnace after melting. The heavy proportions of alloys cannot be added in the ladle. It is sometimes convenient, however, to make extra additions in the ladle, as, for example, if a higher chromium is required than would normally be obtained from the direct melting of addition pigs.

With regard to the smaller additions of alloys, material such as nickel may be added with the charge or in the ladle. The results obtained in the two cases are, however, not the same, and when inoculation is used for the production of high-duty cast iron, then the addition must be made in the ladle.

Heat-Treatment

In the production of high-duty alloy castings some form of after-treatment is frequently given. This treatment may consist in stress annealing, as, for example, at a temperature of about 450 deg. C. for half to four hours, according to section of casting involved. Stress-annealing is particularly valuable in connection with more complicated castings, and is frequently effective in eliminating cracking in service or in machining.

On the other hand, a quenching and tempering heat-treatment may be applied to the high-duty castings in order to produce further improvement in strength or hardness. More details are given with regard to heat-treatment later in the Paper. A further type of treatment sometimes used is local heat-treatment as by surface hardening in order to improve wearing quality in particular parts of the casting.

The Production of High Strength Iron Castings

One of the most successful methods of making high-duty castings with extra high strength is that developed under the name of "Ni-Tensyl." The method of manufacture depends essentially on inoculation by nickel. The base-iron when melted in a cupola consists generally of a charge consisting of 70 to 90 per cent. steel scrap, the balance being selected pig-iron or high-duty iron scrap. This charge is melted down under controlled cupola conditions and with the addition of small proportions of manganese and ferro-silicon to give a hot iron at the cupola tap hole with a composition somewhat as follows:—

Total carbon, 2.7-2.9 per cent.
Silicon, 0.7-1.0 per cent.
Manganese, 0.7-1.0 per cent.

On account of the high proportion of steel scrap in the base, phosphorus will of course be low and, given good melting conditions, sulphur will also be low. After tapping from the cupola, this iron would, if cast direct, give white iron castings. In the inoculation treatment, however, the silicon content is increased to about 1.5 per cent. and at the same time a nickel addition of 1 to 1.5 per cent. is made.* This ladle addition serves to inoculate the iron, giving castings with a fine graphitic structure. The use of the process for the production of high-duty iron castings depends of course primarily on reducing to a minimum the total amount of graphite present in the castings and secondly on controlling the form of the graphite so that it is present in fine flakes instead of in coarser flakes which tend to break up the continuity and strength of the iron matrix.

It should be mentioned that iron of this type is also very successfully made in rotary and air-type furnaces. In these, however, as there is less carbon pick-up the proportion of steel scrap is less and the balance must consist of carefully selected pig-iron in order to give a composition similar to that quoted above. Inoculation can take place inside the furnace when melting is complete and immediately prior to tapping.

In the foundry, inoculated irons of the "Ni-Tensyl" type must be handled with considerable care. The iron has a short freezing range and castings must therefore be poured hot, and it is necessary in addition to allow extra large runners and risers as in the case of steel-foundry practice. Rod feeding is not permissible since on account of the short freezing range the metal would tend to tear.

"Ni-Tensyl" is adaptable to a wide range of section thicknesses and types of castings. In fact it has been found that "Ni-Tensyl" is remarkably adaptable and as reported by Russell† metal from the same ladle can be used for heavy coupling castings with sections about 6 in thick and for small petrol-engine cylinders with a wall thickness of about ¼ in.

The tensile strength of "Ni-Tensyl" is generally of the order of 22 to 25 tons/sq. in. The metal shows a relatively high Brinell hardness, namely, 260 to 300. In spite of this, however, it has excellent machining qualities and frequently gives long curly turnings.

"Ni-Tensyl" is of great importance to engineers to-day, offering as it does an advance of approximately 50 per cent. over the strength of ordinary iron castings. This opens up the possibility of reducing the section thickness in large castings, as for example in winding drums and other parts where by reducing sections and weight substantial savings in power are possible. On the other hand, "Ni-Tensyl" may be used without alteration in design to enable higher stresses to be adopted, whilst perhaps of more

* A Paper read before the Birmingham Branch of the Institute of British Foundrymen, Mr. G. W. Brown presiding.

* The production of iron castings by this process is covered by British Patents 290,267 and 352,510.

† "Ni-Tensyl," Publication B.25 of B.I.N.

importance still is the fact that with its higher strength "Ni-Tensyl" enables the high-duty iron to be adopted for castings for which ordinary cast iron was inadequate and more expensive materials, such as steel, were formerly used. This again is of special interest at the present time when the difficulty in obtaining steel castings is well known.

Examples of the application of "Ni-Tensyl" include large winding drums, machinery castings, and, in fact, all parts where something better than ordinary cast iron is required. An application of considerable interest is in the case of a large crusher frame weighing 20 tons and an average section thickness of 9 in. This casting, when made in "Ni-Tensyl," showed on the test bars a strength of 25 tons per sq. in. and gave a strength of 23 tons in the centre of the 9-in. section. In many cases compositions sometimes containing up to ½ per cent. of molybdenum have been reported with strengths even above 30 tons per sq. in. in the as-cast condition. In addition to the wheel castings mentioned above, the iron has been successfully adopted for cylinder bodies for pumps, machine tool beds and for clutches and gears.

Heat-Treatment of Cast Iron

The improvement in the physical properties of iron castings by heat-treatment is vitally important in the production of high duty castings. In the first place, under the heading of heat-treatment, reference should be made to stress annealing. Generally speaking, in most types of castings, particularly of complicated design, beneficial results are obtained by annealing at a temperature of about 450 deg. C. for a shorter or longer time depending on the section thickness. Such annealing often increases the tensile strength of the metal by 20 or even 30 per cent. without impairing its hardness and wearing quality. The treatment relieves strains which might subsequently cause cracking in service and is further of advantage in eliminating any need to age or weather the castings to prevent distortion after machining.

Of more importance from the heat-treatment point of view, however, is the quenching and tempering treatment now being applied regularly to alloy castings of even relatively heavy sections. Until recently, heat-treatment as applied to steel could not be used in connection with iron castings owing to the danger of their failure due to the quenching stresses. The use of nickel, however, in iron castings has made heat-treatment possible owing to its influence firstly in lowering the temperatures from which heat-treatment must be effected, and secondly owing to its influence in reducing the critical speed of cooling necessary to produce a given result. Thus, whereas in the case of plain iron it would often be necessary to give a water-quench in order to obtain response, in the case of an iron containing 2 per cent. of nickel quenching in oil is nearly always sufficient, the latter treatment being, of course, much safer for the castings. The results obtained by heat treatment have, of course, been discussed in detail in several Papers by Hurst, Russell and others, and it is now well known that by quenching an iron containing round about 2 per cent. of nickel in oil from a temperature of about 850 deg. C. followed by tempering at temperatures between 300 and 450 deg. C. a marked improvement can be obtained in the hardness, strength and wearing quality of the iron, and this treatment is now regularly being applied to such castings as gears, cylinder liners, cams and other machinery parts.

The principle of heat-treatment as applied to the high duty types of iron such as "Ni-Tensyl" has resulted in astonishing strengths, and it is not infrequent to obtain a strength of 35 tons per sq. in. or over, together with Brinell hardness of about 300 to 400 by this means. So far the field of application of such irons has hardly been explored at all, and it is predicted that in the future important developments will take place in this connection.

An interesting example of heat-treated alloy cast irons is found in connection with automobile crankshafts. Experiments on cast iron for this application have revealed that cast iron possesses a valuable property, in that it tends to damp out vibrations to a far greater degree than does steel. At the same time, it has been found that cast iron possesses a very useful degree of fatigue resistance, and these factors, coupled with the heat-treatment of modern high strength irons, have resulted in the adoption of cast-iron crankshafts on an extensive scale in the United States, whilst they are also receiving a considerable amount of attention in this country. In addition to the properties mentioned above, cast iron offers special advantages to the automobile engineer on account of its superior wear-resistance, a factor of some importance in connection with the maintenance of sweet running conditions in automobile engines.

Wear-Resisting Cast Irons

The modern high duty irons possess high hardness-characteristics on account of which their wearing quality is generally good and adapts them for such applications as dies and machine tool beds. The wearing quality of these irons is markedly improved by heat-treatment, as detailed above, and they are thus of special interest for many applications where abrasion-resistance has to be met, as in gears, grinding machine parts, and so on.

Generally speaking, however, where cast iron to meet maximum abrasive wear is required, then it is usual to adopt one of the white irons, which, on account of their massive carbide structures are very hard and resistant to abrasion.

Within the past few years a development of considerable interest has taken place in the production of high duty white cast iron. In this iron, which is known as "Ni-Hard," alloy additions are employed to render the matrix of the iron martensitic in place of the usual pearlitic form. By thus hardening up the matrix of the metal, the Brinell hardness of the casting as a whole, whether cast in sand or against chills, may be increased to something within the range of 700 to 900 Brinell. In addition to the marked increase in hardness produced in "Ni-Hard," the alloys are also effective in giving a finer grain and a tougher casting, and in this case once again long curly turnings can be obtained when rolls and similar products are machined on modern tools.

"Ni-Hard" is applicable to all castings at present made in white or chilled cast iron, such, for example, as crusher parts, parts for sand handling machinery in the foundry and for shute plates and many other similar applications in quarrying and mining. The principal application of "Ni-Hard," however, is for chilled rolls for use in the crushing industries or for metal rolling of all types. "Ni-Hard" for such rolls offers special advantages of greater strength and toughness, improved wearing quality and freedom from tail marking. In view of the difficulty of obtaining stress-free hardened steel rolls, "Ni-Hard" is of particular interest where hard rolls are required, and they can even be produced with a high degree of finish suitable for the cold finishing of many types of mill product.

A special application of modern high-duty cast iron in connection with wear and which is of outstanding interest at the present time is found in the automobile industry relating to cylinder bore wear. This is a special application of such interest in the Midlands that no apology is made for dealing with it in some detail.

In the early days of the automobile industry the softer, coarsely-graphitic types of cast iron gave excellent results, the graphite acting as oiling pads and the metal being of such a quality that it took on a hard glaze which was effective in giving satisfactory life. With the development of automobile practice, however, higher efficiency has been constantly demanded, and it was not long before it was found that the soft grades of iron previously used were inadequate to meet modern conditions, and the glaze which previously formed was, under the higher pressures, no longer stable. The first step in meeting this position was the use of harder grades of cylinder metal. This, however, led to machining troubles, and one of the first solutions of the problem was found in the use of nickel-alloy cast iron for block castings. The nickel addition to cylinder iron enabled a satisfactory hardness to be achieved in the cylinder barrels, whilst adequate machinability was maintained in the thinner outer sections of the casting. Progress, however, soon demanded something better still, and attention was given to cylinder liners, which enabled metal of controlled composition to be inserted into the cylinder barrels. Alloy cast irons were used for many of these types of liners, but when better results still were needed, attention was given to the heat-treatable types of iron referred to above.

At the same time as the heat-treatable types of iron were adopted, certain manufacturers spent considerable time and effort in adapting the harder grades of nickel cast iron produced by the addition of at least five per cent. of nickel. These irons can be regarded as in the heat-treatable iron series, but with so much alloy that the critical speed of cooling necessary to harden them corresponds to the rate of cooling in the foundry, so that the irons are hard as cast. These irons certainly proved difficult to machine, but with modern machine tools these difficulties were in due course overcome. Such irons have now been established to give extremely good wear in service owing to the stable nature of their hardness, it being thought nowadays that in the heat-treatable irons there is a distinct tendency for the surface hardness to be "let down" in operation.

At the same time, the Institution of Automobile Engineers evolved their theory that cylinder wear is frequently corrosive in nature. This led naturally to the study of the modern corrosion-resisting austenitic cast irons for this application, and it is a fact that now these austenitic irons are successfully being used in many cases where corrosive wear is present, as in engines running under cold conditions, for example, when constantly stopping and starting and with only short intermediate runs.

The position to-day with regard to cylinder wear is roughly be summarised in Table I.

Table I.—*Relative Life Given by Cylinder Materials in Automobile Engines.*

Predominant nature of wear.	Wear—Hot engine.	Wear—Cold engine.
	Abrasive.	Corrosive.
Cast iron cylinder block ..	15	4
Cast iron liner	20	6
Nickel cast-iron block or liner	25	10
Heat-treated nickel cast-iron liner	40	15
5 per cent. nickel liner as cast	100	30
Austenitic liner	(100)	100

Note.—Hot engine conditions—continuous service and long runs. Cold engine conditions—stopping and starting engine and short runs.

The Austenitic Cast Irons

In meeting conditions where corrosion is likely to be encountered, the best results are obtained by the highly alloyed austenitic types of cast iron. These are well known under such names as "Ni-Resist," Nicrosilal, Nomag, etc. These irons were first recognised by Dawson in 1924, who introduced Nomag as a cast iron with a non-magnetic quality suitable for electrical engineering purposes. A few years later "Ni-Resist" was introduced as a corrosion and heat-

resisting metal. These irons are now widely adopted in the domestic, chemical and general engineering fields for pumps, valves, pipe and fittings where corrosion has to be faced. Whilst equivalent in many respects to the brasses and bronzes, the austenitic irons have a special advantage in possessing to a marked degree resistance to abrasion and erosion. This is specially valuable in connection with such parts as pumps handling sandy water and actual examples are found in the pump equipment installed in the last few years in the King George V Graving Dock at Southampton, and in the new train ferry dock at Dover. In each of these cases the austenitic type of cast iron has been adopted for the pump impellers in order to give the desired degree of combination of corrosion and erosion resistance to attack by the sandy sea water handled at high velocities.

The austenitic irons also possess a marked degree of heat resistance and they are particularly valuable for use in furnace applications where a cheap material with good resistance to oxidation and growth is required.

Expansion Control

Several of the highly alloyed austenitic cast irons have special expansion characteristics which make them particularly suitable for use in the construction of automobile engines and in similar applications where the irons are required to operate under fluctuating temperatures in conjunction with aluminium or other high expansion alloys. The austenitic iron possesses a coefficient of expansion of 18 millionths, this being some 50 per cent. greater than that of ordinary cast iron and approaching very closely to the expansion coefficient of aluminium. Irons containing even higher proportions of nickel are characterised by having low expansions which are of special value in the construction of certain particular parts such as dies which are required to retain their dimensions to a high degree of accuracy whilst subject to superheated steam temperature.

Conclusion

It is, of course, not possible to deal in any very great detail with any one class of the modern high duty alloy cast irons in a general lecture of this type, but is hoped, however, that the information given will be sufficient to emphasise the way in which modern metallurgy is helping cast iron to meet the more exacting requirements of the engineer.

Vote of Thanks

A vote of thanks to Dr. Everest, proposed by MR. P. A. RUSSELL, and seconded by MR. J. G. S. PRIMROSE, was very heartily accorded.

DISCUSSION

Opening the discussion, MR. E. NOBLE commented that Dr. Everest had made no comparison with Monel metal, " Everdur " or aluminium bronze in his references to corrosion resisting cast iron. He would be very interested to hear of anything that gave better corrosion resistance than these metals. Cost was, however, an important factor, for the non-ferrous metals cost only 1s. 1d. to 1s. 3d. per lb. He asked what material Dr. Everest would recommend for a cylinder casting weighing two tons and with a 5 in. wall thickness.

MR. A. G. HARRISON inquired what temperatures were employed in American cupola practice for the production of high-duty cast irons and whether an extra heavy charge or other modifications in cupola working were used.

Stress Annealing

MR. RUSSELL pointed out that the lecturer had not produced any evidence that stress annealing gave better results. He would like to know if stress annealing was necessary for high-duty cast irons, as it involved an expense which it was desirable to avoid if possible. Referring to heat-treatment of inoculated cast iron, he stated that, in his own experience, the Brinell figure did not drop as sharply after heat-treatment as the lecturer had shown. He had found that the figure for Brinell hardness remained at over 300 even after tempering at 500 deg. C., and he inquired whether the material used was an inoculated cast iron. With reference to cylinder wear and austenitic liners, he noticed that the wear curve showed a slight amount of wear at the start and then flattened out. In his opinion, that suggested the possibility that there might be slight surface breakdown in the austenitic liner. It might be that the use of a low nickel austenitic metal giving a mixed martensite-austenite structure might be more suitable for liners.

MR. J. H. DOLPHIN asked what proportion of the special ingredients of the metal were charged in the cupola and what proportion added in the ladle when producing inoculated cast iron.

A Steel Scrap Problem

MR. F. P. OLLENSHAW stated that when using 25 per cent. steel scrap he obtained better results with steel rails than when using fish plates, and he inquired if Dr. Everest could give him the reason.

Mr. Ollenshaw asked if, in the production of synthetic base iron for high-duty castings, the iron should be poured into chill moulds or into dry sand.

Referring to Dr. Everest's statement that in inoculation 1 per cent. nickel and 1 per cent. ferro-silicon were used, MR. P. R. HARRIS asked how this would affect the temperature of the metal. He had in mind particularly the application of the metal to small castings such as flywheels where a high pouring temperature was required. He asked, further, what special advantage could be obtained by the use of calcium silicide in place of ferro-silicon as an inoculant.

After mentioning that in the motor industry, shrinkage was claiming considerable attention, the CHAIRMAN (Mr. G. W. Brown) stated that though the cost of nickel was prohibitive to many, it should be realised that cost was only a secondary consideration in the production of the best article possible. Mr. Brown asked whether special foundry skill was necessary in handling high-duty cast iron.

MR. PRIMROSE said that some distinction should be made as to what was cast iron and what was not. He was glad Dr. Everest had referred to damping capacity and high impact values, for he thought that a high impact value was considered by some to be of paramount importance, but he was amazed by the low impact values of certain foreign crankshafts. This stressed the considerable importance of damping capacity as opposed to impact.

Author's Reply

DR. EVEREST, in reply to Mr. Noble's question, stated that as a general rule " Ni-Resist " could be taken as very similar in price and in corrosion resistance to brass and bronze. He would expect that from corrosion resistance alone the austenitic iron would not be as good as Monel metal and the other alloys mentioned. On the other hand, the wear resistance of " Ni-Resist " was superior owing to its tendency to work harden and so give superior erosion resistance. This was particularly valuable in connection with the pumping of liquids containing solids in suspension. For the large cylinder referred to by Mr. Noble, Dr. Everest stated that inoculated cast irons would be quite suitable and were in fact being used extensively for heavy castings of the type in question.

Replying to Mr. Harrison's remarks, Dr. Everest stated that high tapping temperatures were generally necessary for the successful production of high-duty cast irons, and he advocated a melting temperature approaching 1,450 deg. C. Whilst this temperature was high compared with ordinary cast iron practice, it was nevertheless readily attained with good cupola working. Most of the high-duty castings shown in the course of the lecture had been made from cupolas under these conditions. No special modifications of cupola working were necessary apart from a high coke bed, fast melting conditions and an efficient control over cupola operations. Success depended a great deal upon having a well designed cupola to give the required fast melting and keeping it in good condition and operating it intelligently.

Replying to Mr. Russell, Dr. Everest confessed that he had spoken perhaps rather from a general conviction that stress-annealing was beneficial to most castings especially if of complex design. He had not with him any data to support the recommendation for such annealing. It was, however, generally recognised that in castings there was likely to be a large amount of stress which could be released by such annealing, and he had heard of many cases where strength and toughness were markedly improved by such treatment. For example, in motor-car cylinders, cracking troubles such as often occurred between the cylinders and valve seats could frequently be eliminated by this means. The iron used as the basis for the heat-treatment test referred to in the lecture was not an inoculated iron, and Dr. Everest stated that the results of heat-treatment would largely depend on the class of casting under investigation, and he was not at all surprised to hear that the hardness was maintained in the tests carried out by Mr. Russell on high-duty iron.

Austenitic Liners

With regard to the question of wear in austenitic liners, it was possible that some breakdown of the surface had taken place and accounted for the change in slope of the curve. Dr. Everest stated, however, that he suspected that this phenomenon could be explained more easily by the usual " bedding-in " which appeared to take place in cylinders of most types. The objections to running a low nickel austenitic iron for cylinders would be, first, the great difficulty such material would introduce into the machining operation, since the mixed martensite-austenite structure was almost unmachinable in spite of a low Brinell hardness, and, secondly, the mixed structure would lack the corrosion resistance of the pure austenite and would therefore tend to fail where corrosive wear was under consideration.

When making inoculated cast iron all the manganese and a proportion of the silicon should be added with the charge in order to ensure sufficient fluidity in the metal for it to be tapped readily from the cupola. All the nickel and the balance of the silicon (generally 1 per cent.) were added in the ladle. Alternatively, they were added as inoculants in the rotary furnace after melting was completed and before tapping.

Remelted Iron

Dr. Everest could not offer any explanation to Mr. Ollenshaw for the difference in the results he obtained when using steel rails or fishplates in the charge. The only point that occurred to him was that occasionally some small pieces of manganese steel might be mixed with the ordinary steel and might affect the results. With regard to the question of synthetic irons, Dr. Everest stated that Mr. Ollenshaw seemed to be under a misapprehension. He wished to emphasise that in making inoculated irons the synthetic iron was not pigged for remelting, but was inoculated immediately after melting and used for the castings directly. If remelted it would most likely lose its advantageous low carbon content.

Replying to Mr. Harris, Dr. Everest stated that for small castings " Ni-Tensyl " was found to be quite satisfactory, but its freezing range was shorter than for ordinary cast iron, and it would not do to use cold metal as the result of transferring to small shanks and carrying for long distances.

(Concluded on page 273.)

Turning Cast-Iron Borings to Profitable Account

EFFICIENT MEANS OF BRIQUETTING

The practice, or at least the possibility, of briquetting metal swarf is comparatively old. Indeed, it is probably 30 years or more since machines were first introduced for the purpose, since when a considerable amount of useful work has been done, more particularly in the non-ferrous metal industries, but comparatively little with steel. Steel turnings and the like do not readily lend themselves to a briquetting process, and, further, the very lightest of steel scrap can be turned to profitable account in the electric furnace. Still less has been done in the case of cast-iron borings and turnings, though such material lends itself remarkably well to the briquetting process, and a machine was developed for this duty upwards of 20 years ago by William Johnson & Sons (Leeds), Limited, of Leeds.

Known as the " President " briquetting press, the machine was evolved as the outcome of very considerable experience of the briquetting industry gained during a period of 20 years, in which time they had developed machines for briquetting iron ores, dolomite and magnesite bricks, and other similar duties, as distinct departures from coal-briquetting machinery.

In the early days of the development, a few machines were installed for dealing with cast-iron borings. Generally, however, the proposition does not appear to have been seriously regarded, mainly, no doubt, because of the negative value of the material to be dealt with, whilst a further factor was the industrial depression through which we have passed.

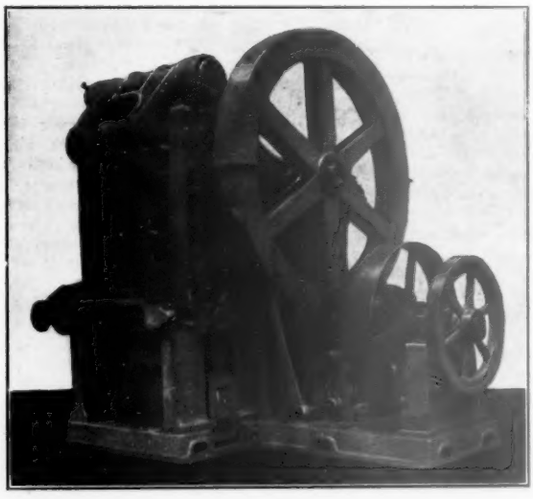


FIG. 1.—VIEW OF THE TOGGLE PRESS.

Apart from the difficulty of obtaining raw material, it is imperative to turn every asset to commercial account, and in this connection there are certainly greater possibilities than are at present in general practice for the use of cast-iron borings.

The question is not one as to the value of the raw material, *i.e.*, the borings and turnings, but the value of the finished briquette considered in relation to the cost of production.

The " President " toggle press has previously been described in our columns, but reference may be made to its salient features.

The press is mechanically operated, and by the adoption of the toggle lever with knuckle joints is capable of exerting 250 tons pressure. The mould is of the stationary type, which enables the mechanism to be considerably simplified. The depth of the mould for filling purposes is adjustable, and can be regulated whilst the machine is in operation.

The press is protected against excessive overload, such as might result from a piece of solid metal entering the mould, by provision of a hydraulic reaction embodied in the bottom pressure block, fitted with an automatic atmospheric and relief valve, also a gauge showing the actual pressure exerted at each stroke. The complete plant consists of little more than the press and its driving motor.

In operation, the youth who collects the swarf tips it into the boot of the elevator, which discharges into a hopper; this acts as a reservoir and enables the plant to function continuously. The hopper feeds on to an automatic measuring table, which ensures a steady and constant supply to the press, this last delivering the finished briquettes on to a table for removal by the attendant.

The normal capacity of the machine is 1,800 briquettes per hr., and assuming that the plant is working continuously at its rated output for 2,350 hrs. per year, *i.e.*, 47 hrs. per week for 50 weeks, the total cost per ton of briquettes produced will be 5s. 5.3d., a cost which is inclusive of interest on capital, depreciation, renewals, labour, power, etc.

In the matter of labour only one man is taken into account, as the youth collecting the swarf is not an additional charge on the works.

The suitability of the briquettes for the cupola is, of course, a factor of first importance. On this point we are able to give some interesting particulars which were furnished at the close of last year by the users of a " President " press which was supplied as far back as 1923.

The output of the press is 700 to 720 briquettes of 3¼ lbs. each per hr., *i.e.*, say 1 ton per hr. Two men are employed on the plant, one feeding the borings into the elevator, the other operating the machine and removing the finished briquettes. The first man should not have been charged up, as he would doubtless be employed in removing the borings and might as well deliver them to the boot of the elevator as to the usual dumping point.

There is no record of the costs of repairs per ton of briquettes, but considering the work had from the machine the cost of repairs is negligible. The greatest cost is in replacing the dies, this being necessary about every month when the machine is in full work. The power taken is approximately 12 b.h.p.

The briquettes are used as scrap in the cupola in the proportion of up to 120 per charge, the charge being 34 cwts. This represents approximately 10 per cent. briquettes. The loss during melting amounts to 11 per cent. and includes the loss in slag, moisture, borings lost in sparks and other foreign matter. Test on loss of borings collected in the cupola spark chamber, *i.e.*, unmelted borings blown into the spark chamber using borings with every charge of metal.

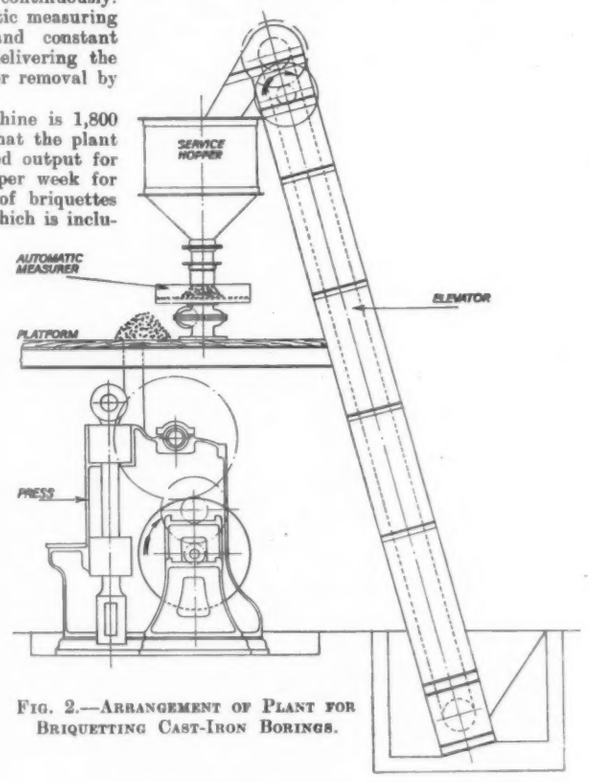


FIG. 2.—ARRANGEMENT OF PLANT FOR BRIQUETTING CAST-IRON BORINGS.

Catalogue Received

Fans. Catalogue No. 1,006, recently issued by the Sturtevant Engineering Company, Limited, of 147, Queen Victoria Street, London, E.C.4, is of particular interest to foundrymen. The range of fans described and illustrated is of the Monogram type, which has been extensively used for cupola blowing. Foundries need many different types of fans, for in addition to the cupola, they are an essential item of many crucible melting plants, rotary furnaces, ventilating plants for the shops and laboratories, core driers, collecting waste from the patternshop, enamelware driers, dealing with sand-blast dust, and many other applications. An interesting table is given on page 16 of cupola performance related to diameter, the fan, the fan speed, the volume given, the pressure at the fan and the horse-power required. There is in addition a wealth of technical data, and good illustrations scattered throughout the twenty odd pages. A letter to the issuing house will procure a copy for any of our readers.

ORDERS PLACED in Great Britain by Soviet Russia last month amounted to £2,289,465, compared with £845,079 in February, 1935, it is learned in official Soviet circles.

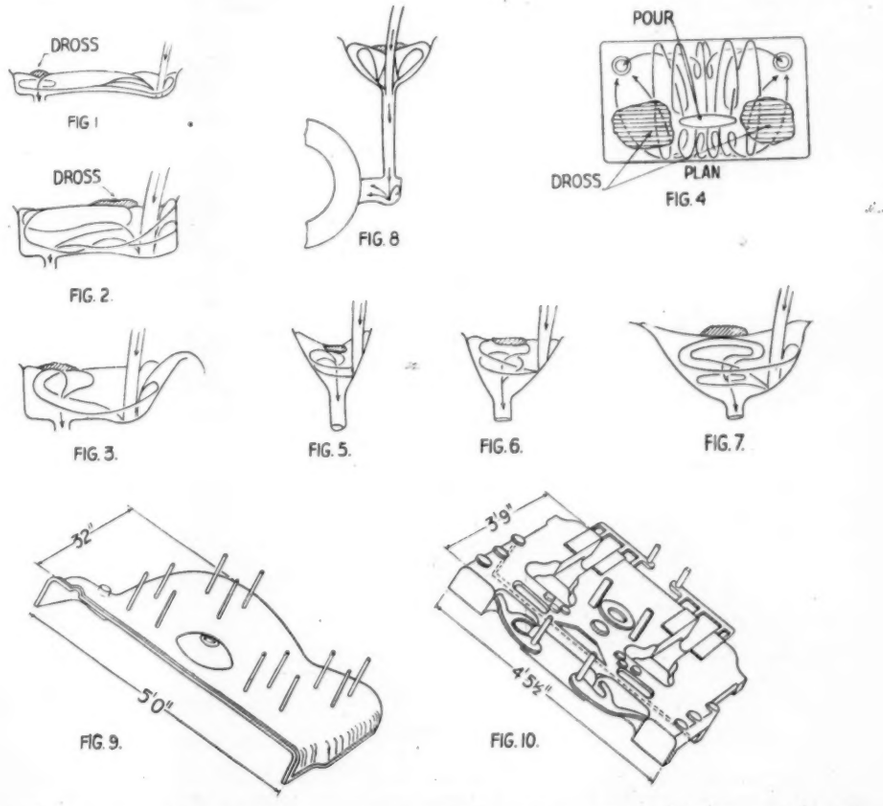
Runners and Risers for Grey Iron Castings*

By JOHN LONGDEN

The runner arrangements for grey iron castings must be related to certain elementary and important principles. The runner basin, down-gate and any in-gates provided are part of a single system, which must be viewed as a whole. For work of importance, the runner basin should have a capacity of at least 400 cub. in. for each sq. in. of cross-sectional area of the down-gate, but even where this proviso is met, its effect can be negated by the faulty shape of the runner basin. Long, narrow and shallow basins, as depicted in Fig. 1, should be avoided, for dross gathers over the down-gate and is easily sucked into the casting. The type of basin shown in Fig. 2 is much more satisfactory, for the currents set up tend to bear dross away from the down-gate, besides which the greater depth of basin tends to ensure that only clean metal enters the down-gate. An undesirable form of basin is shown in Fig. 3, where the sloping front reduces the basin capacity and results in metal being flung out of the basin whilst the man pouring is struggling more or less ineffectively to keep the basin full.

For heavier work, where two or more down-gates enter one basin, the rectangular basin is to be preferred, with, if possible, a length of about one and a-half to twice the breadth, and a depth of at least one-third the length of the down-gate. The currents set up in such a basin are depicted in Fig. 4, and the dross is drawn away from the down-gates. For some classes of work, the shape of the basin must perforce be irregular, but the same general principles apply. Important work of more than a few hundredweights should have all down-gates ball-plugged. For smaller work, covering the gate with a perforated tin disc is satisfactory.

For small work, the tun-dish basin shown in Fig. 5 is often used, but is only suitable for hand-ladle castings, small down-gates making it possible to keep dirt out of the mould. With any but a small gate it is almost impossible to keep dirt out. The tun-dish types shown in Figs. 6 and 7 are better, but have little to commend them. This type of basin is particularly objectionable in crane-ladle work, where, owing to the size and shape of the basin, the stream of metal may be directed straight into the down-gate, as shown in Fig. 8, resulting in a severe cutting and straining action in the region of the in-gate. The down-gate in any basin should be kept to one side, so as to avoid this possibility. In a green-sand mould, the sand grains are bonded with moist clay, the mechanical strength of which is incapable of withstanding the direct impact of a stream of metal falling from any considerable height. This is less true of dry sand and loam, but is still significant.



Fundamental Factors

Factors influencing the speed and completeness with which molten grey iron fills a mould are:—(1) Its pouring temperature; (2) the velocity attained in descending the down-gate; (3) the degree of frictional resistance set up by the walls of the mould; and (4) the degree of freedom from change in the direction of travel. These factors must all be considered in relation to size and position of gates. A primary question is: How far will molten grey iron run? Briefly the answer is that it will continue to run from a higher to a lower level, to any distance from the point of entry, as long as it remains liquid. Having regard to attainable temperatures for cupola melted metal, and to radiation and conduction losses suffered by the metal as it travels in a mould, there is a limit in practice.

Grey cast iron, dependent upon its composition, ceases to be wholly liquid at temperatures ranging from 1,230 to 1,240 deg. C. At temperatures below this, particles begin to solidify, and the metal becomes rapidly more and more inert. The moulder recognises readily three ranges of temperature; dull, hot and "damned hot." The last condition is recognisable by the will-o'-the-wisp blaze on the clear surface of the metal, undoubtedly due to a flame burning the carbon to its oxide. A higher temperature still is indicated when a black smoke or fume rises from the metal. To the trained eye, the surface of cupola melted iron bears a useful indication of its temperature. From diffident estimations made by the writer with an optical pyrometer, it is suggested that when the "blaze" becomes intermittent, slowly giving place to the characteristic surface "break," the temperature has fallen to about 1,350 deg. C. This temperature, affording over 100 deg. C. superheat, gives a useful datum line for visual judgment of the suitability of iron temperatures for given jobs, and is probably the best temperature at which to pour castings having to withstand pressure tests.

Lower temperatures, except where general section thicknesses are heavy, lead to trouble. Very light castings, such as the guard casting shown in Fig. 9, are best cast with the "blaze" still on.

Running a Guard Casting

The guard casting affords an illustration of the necessity of placing gates to obtain quick distribution of the metal throughout the mould and in such a manner as to avoid distortion of the casting. Its area is considerable, having regard to its general thickness, which is ¼ in. In filling the mould, the streams of liquid metal are subject to frictional hindrance above and below. Therefore, the gates must be well distributed, so that the stream of metal from any one gate has not far to go before it joins with the others. This casting can be cast quite well with a spray runner along the straight edge of the casting, supplemented by two groups of drop-gates at the rear, as seen in the sketch. Unfortunately, the spray runner bends the straight edge, since this is made the hottest part of the casting. In any casting, the heavier parts, or, alternatively, the hotter parts, cool last. This means that they contract last. If the last part to contract is tied to a body of metal which cannot contract with it, it must bend or break the casting. This is demonstrated in the phenomenon of camber, the breaking of pulley arms, etc. The casting shown in Fig. 9 comes out quite straight if poured through four groups of three ½ in. dia. drop gates, as shown in the sketch.

In making light castings, much use is made of the drop gate, which is often wedge-shaped, narrow and long where it joins the casting. The joint spray is also much used for heavier as well as light castings, and often affords the best means of ensuring satisfactory distribution and avoiding local "hot spots." It must, however, be used with care. Usually, a down-gate from the runner basin is placed over a long or short channel cut in the joint, from which the sprays are cut, of convenient size and spacing. If the channel is long and deep, as is necessary in the case of larger castings, with fairly strong sprays or in-gates, there is sometimes danger of breaking the casting. If the actual casting in the region of the runner cools last, no harm will be done, but if the runner channel cools last, it may tear a piece or pieces out of the casting. This can be obviated by breaking up the spray into one or more disconnected sections, fed from separate down-gates.

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. F. Hudson presiding.

Combination Drop Gate and Joint Spray

An example of the use of a combination of drop gate and joint spray is shown in Fig. 10. The general thickness of this casting is $\frac{3}{8}$ in. The down-gates are grouped into one long runner basin across the middle of the top part. The common pipe, cast on the flat, offers some variation in the arrangement of runners. Short lengths of small diameter may be cast quite well with runners as shown at A or B, Fig. 11.

Pipe and Cylinder Castings

Runners at one end of a 4-ft. pipe, as at A, Fig. 12, are usually sufficient. For longer ones up to 8 ft., similar runners at each end are satisfactory. For still longer lengths, these runners are supplemented by drop runners on the body, as at B, Fig. 12, or by suitable sprays on the joint, as at A, Fig. 13. Large-diameter pipes offer more difficulty. The types of runner detailed above are sometimes used for large pipes, but have little to commend them. The best runner for a large-diameter pipe is as shown at B, Fig. 13. Here the metal has a free, uninterrupted sweep up the body of the pipe, making for reasonable freedom from faults.

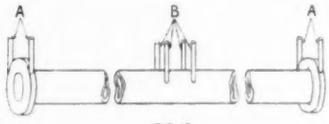


FIG. 12.

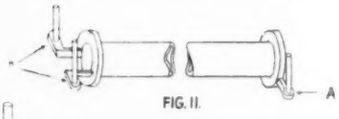


FIG. 11.

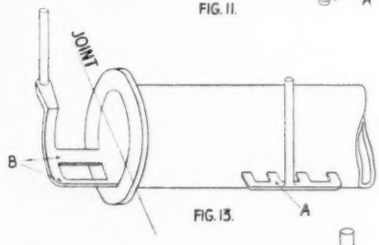


FIG. 13.

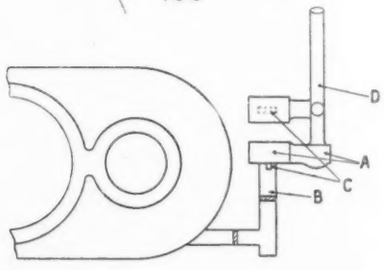


FIG. 15.

Whilst such a runner is quite satisfactory on a pipe or similar casting, it would be quite unsuitable on the bore, say, of a piston or slide valve cylinder cast on the flat. There must be few castings, whether made in green sand, dry sand or loam, in which small or large portions of the mould surface are not detached owing to the scouring action of inrushing metal. These pieces, sometimes only particles, aggregate usually at places not far from the in-gate, and gas bubbles, caused by turbulence, accumulate there. Such patches on the bore of a cylinder would make it defective. For castings of this type, in-gates must be at convenient places where either any small defects are not so damaging, or dross can be conducted into a convenient head. Fig. 14, showing a simple slide-valve cylinder, illustrates this point. The in-gate A, running into the flange of the steam chest at the joint line, has the advantage of being well away from the bore, but is not good. A runner of this type makes for excessive turbulence in the region of the in-gate, which induces scabbing of the mould and a frothy condition of the metal. The in-gate at B is much better, giving a free run for the metal to the end of the flange, with less turbulence. The small dross-head C, directly above the point of entry, will take care of any dross which may gather, and is easily cut away. The fountain gate at D is better still, as the metal, welling up from below, is less scouring. Cylinders of this type, up to a bore of 18 in., have been made successfully in large numbers in green-sand moulds, the larger ones being skin dried.

Heavy Cylinder Practice

Large numbers of heavy cylinders, made in dry sand, have been cast successfully horizontally. Fig. 15 shows one end flange of a piston valve cylinder, with down-gate and in-gate, together with a form of trap runner. The metal falls down the gate D into chamber A, from there passing into down-gate B. Where B leaves A, however, it is restricted by the introduction of a slot core at C, which reduces the cross-sectional area of the down-gate B at this point to some 75 per cent. of that of down-gate D. The metal therefore rides a little in chamber A, where dross tends to be held.

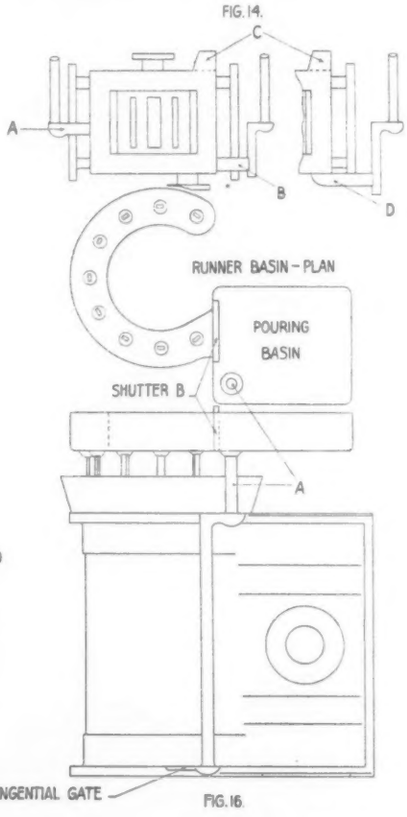


FIG. 14. FIG. 16.

Large cylinders are usually cast on end, with, if possible, a suitable head above the bore. The best runner system is a combination of drop and bottom running, and this is shown in Fig. 16. The in-gate on the bottom joint is placed so that the metal enters the mould tangentially, or it may be sprayed under the steam chest. Only one down-gate, with in-gate, is shown in the sketch, but very large cylinders may need two or more, together with gates providing entry into the flange of the steam chest, or other convenient point of entry, about half-way up the mould. Further, where possible, the down-gates to the bottom should be stepped, to reduce the velocity attained by the metal on its entry into the mould.

Fig. 16 shows, at the top, a plan of the runner basin. The down-gate A is deflected at the top, thereafter passing down to the bottom joint. This runner is ball-plugged at the basin entrance and at B is a shutter which can be lifted at will. The basin is continued behind the shutter and contains the drop runners, which are also plugged. In pouring, the basin is filled and the down-gate A plug is drawn. When the bottom of the mould is estimated to contain some six to nine inches of metal, shutter B is lifted out and, when the whole basin is again full, the plugs on the drop gates are lifted out. Pouring is then completed. The drop runners are spaced some eight or nine inches apart, all round the bore, except in the region of the ports, no runner being nearer a port than nine inches. The shutter is advantageous, for without it there is a danger that a trickle of metal will find its way under the plugs of the drop gates, and will not drop straight down, but creep down the walls of the gate and mould, becoming a streak of solid metal on the core or mould wall, which may or may not be remelted. In any case it is oxidised and a source of danger.

Liners which have a nest or nests of ports are usually cast similarly. The first metal passes down from the basin through a runner along the joint to an in-gate at the bottom of the mould. When the metal reaches the neighbourhood of the ports, drop runners from the top are opened and pouring is completed. Liners without ports are best run with drop runners from the top.

Any truly cylindrical grey iron casting, having to be machined and pressure-tested, is most likely to be sound if cast on end, with suitable provision of dross or feeder head. This gives the simplest form of runner, *i.e.*, the straight drop from the top. Runners of this type, the cross-section of which is rectangular, should be located, and so arranged that the streams of metal fall clear of mould or core surface. This is difficult in practice unless the metal section be thick, and it is necessary that the mould be set up for pouring with the aid of a plumb-line to ensure that it is quite vertical. Obviously, the longer the mould is, then the less likely is it that the falling metal will not hit core or mould surface somewhere before reaching the bottom.

Roller Castings

Fig. 17 shows the arrangement of runners and basin for a 36-in. dia. roller, 10 ft. long. The drop runners are sixteen in number, each $1\frac{1}{8}$ in. by $\frac{5}{16}$ in. in cross-section. It is not intended here to over-emphasise the relative value of the rectangular drop runner as compared with the round one in such a case. If a runner basin be made up having two gates, one rectangular and one round, of the same cross-sectional area, and if the basin be set up in such a way that the metal falling through the gates can be observed for a distance of 3 or 4 ft., it will be seen that, whilst the metal from the round gate keeps its cylindrical shape, the metal from the rectangular gate keeps the form set by the gate for only a few inches and then gradually draws together, so that, some 15 in. below the gate, both columns of metal are apparently alike, *i.e.*, cylindrical. Nevertheless, the temporary flattening of the downward stream will usually enable the metal stream to drop safely below top flange fillets and the like before broadening out. The narrow, rectangular runner may also be said to exercise a modified strainer effect.

Rollers, liners, rams, pans, straight hydraulic pipes and similar types of castings are usually cast on end with drop runners. In this method the heavy impact with which the first metal to fall is detrimental strikes the bottom face of the mould. In the case of a roller, of the type shown in Fig. 17, with a flanged bottom face, the impact is severe, but, after the first blow, the metal itself forms a cushion to take the impact. The conditions are different in the case

of, say, a hydraulic ram or a pan where, as illustrated in Figs. 18 and 19, the first metal drops on the spherical surface at the bottom and continues to batter the same spots until the base of the mould is full. In the case of the hydraulic ram (Fig. 18) plenty of runners with a correspondingly small cross-sectional area so as to reduce the severity of the impact at any one spot must be provided, and the bottom must be made in special materials to resist the attack.

Running Pan Castings

In the case of pans, up to 5 cwts. of the type shown in Fig. 19, where the mould material is suitable, they can be cast quite well through a single runner going down through the centre of the core into the bottom of the mould. Larger pans, up to 25 cwts., can be cast with three, four or five drop gates. Larger pans are better with similar runners spaced all round, as shown at A. Where such pans are very heavy and deep, the danger of fracturing the mould surface by drop runners is serious, and an alternative is sometimes used in the form of the bottom gate shown at B, supplemented by drop runners from the top. A scabbed mould makes the bottom of the pan unsatisfactory for its work, but this bottom runner is not without its danger, for the stream of metal impinges directly on the rounded bottom surface of the core. In the case of very heavy pans, the mould is sometimes cast the reverse way up. Bottom runners are then sprayed into the flange, supplemented by sprays at a joint nearer the top.

A further consideration is that, when molten iron falls from a height, it splashes on impact with the bottom, forming oxide-covered spots. Consequently it would be foolish to run the steam cylinder shown in Fig. 16 with drop gates only. Some oxidised particles, reacting with carbon in the molten stream around it, would be swept or splashed round underneath the ports, and a defective bore would result. With castings of straight cylindrical form, however, the drop runners, if evenly spaced, effectively bring from the bottom up into the head any oxidised particles and dross.

Machine Tool Castings

Probably the plain, cylindrical casting, poured on end, presents the least difficulties in running of any of the heavier castings. Bed plates, lathe and other machine tool beds and castings having large horizontal surfaces offer more difficulty. Bottom running is always resorted to, supplemented by in-gates at higher levels where the depth of the mould is considerable. The question again arises: How far should molten grey iron be expected to run from any one set of gates? In practice one sets a limit; for any given degree of casting temperature and composition a thicker stream of metal will travel farther than one of thin section, owing to the reduced frictional hindrance. No difficulty is found in running from one end castings 14 ft. long, of a construction similar to that shown in Fig. 21, having a metal thickness of ¾ in. with iron low in Si and P. These are, however, inclined from the runner for pouring, and one would hesitate to cast them from one end on the flat.

Recently the author was privileged to see some very fine machine tool beds at Craven Bros. (Manchester), Limited, including one 35 ft. long, weighing about 27 tons. This was cast through two sets of in-gates, one set at each end comprising four in-gates, each 5 in. by 1⅛ in., placed at the shear faces. The streams of metal from each end must travel 17 ft. 6 in. before meeting. If perfect coalescence is to be obtained the two streams on meeting must be wholly liquid. This coalescence takes place on the shear faces, which are heavy. When these are full, however, the metal must climb through relatively thin sections and must have sufficient superheat to enable it to do so. A bed 41 ft. long was cast by the same firm, but the end runners were supplemented by additional gates at about half-way along its length. These were opened when the mould was half full, to liven up the metal at that spot. In this case, therefore, the metal from each end bottom runner had to travel 20½ ft. before meeting the opposite stream. This distance probably represents the limit of distance a stream of molten grey iron should be expected to travel in a mould.

Where large quantities of metal pass through a gate, the region of the mould in its vicinity becomes very hot. Consequently, in such areas, difficulties may arise in respect of open grain or burning on of chills, if used. Further, when molten iron runs any considerable distance, the advancing spear-head of the metal must become oxidised a little, collecting, as it runs, small particles from the surface of the mould. That spear-head, therefore, may form a spongy spot at the far end, or where two streams meet, such spot being disclosed later under hydraulic or steam test. In the case of the casting 14 ft. long run from one end, referred to above, provision is made for the first 14 lbs. or so of metal to be run off through a channel into a chamber head.

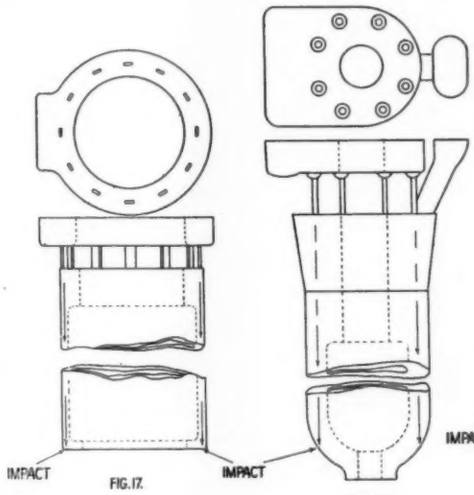


FIG. 17.

FIG. 18.

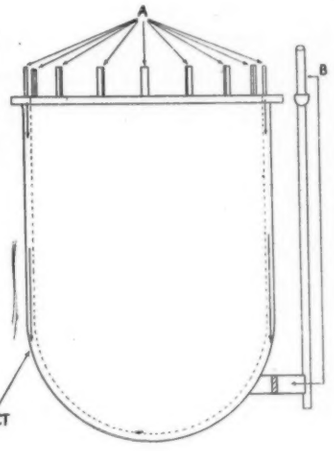


FIG. 19.

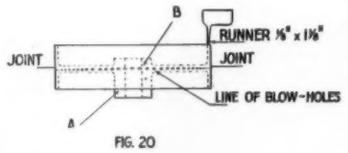


FIG. 20

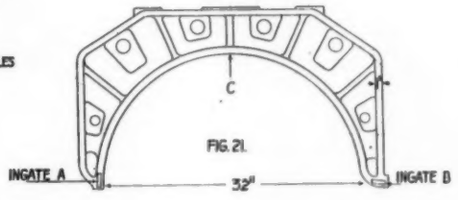


FIG. 21.

A Pulley Casting

Attention is now directed to the 16-in. dia. pulley shown in Fig. 20. Many thousands of these have been made by machine, jointed and gated as shown, with abnormally small scrap losses. A number of castings were returned from the machine shop, however, after the rims had been turned, showing a remarkable series of blow-holes just below the joint, as shown in the illustration. This was puzzling, but investigation showed that the moulder, for the first time, had cast them with the deeper boss, A, down. The order was reversed and trouble ceased. It is worth while to consider this example. The pulley is normally cast with the shallow boss, B, down. In pouring, the mould fills slowly till the level of the arms is reached, when metal runs along them into the boss. The steady rise in the rim comes to a halt whilst the bottom boss fills and thereafter the rise is slower whilst the arms and boss continue to fill. The halt in the rise of the level of metal is longer with the deep boss down than with the shallow. The metal slightly oxidises around the outer edge of the rim, and when the metal again begins to rise, it fails to lift a minute rim of oxide, which, when the molten metal rises above it, reacts with carbon, leaving entrapped bubbles of carbon monoxide.

A similar instance is the 3½-ton casting, a cross-section of which is shown in Fig. 21. It is a 10 ft. long steam chest, the semi-circular undersurface of which is machined and polished. The core is much intersected by strong longitudinal and lateral webs. The mould is inclined, for pouring, from the runners, which are at one end in the positions A and B shown in the sketch. A large number of these castings have been made without any trouble, but one, after polishing, showed a fine hair line, about 4 in. long, on the surface at point C, at the end opposite the runners. There was no leak under water or steam test, but examination with a high-powered glass showed the line more clearly. It was not a crack, but apparently a line of oxide, and the presence was disclosed, at intervals, of a number of minute blow-holes, invisible to the naked eye.

This case was diagnosed as being in line with that of the pulley discussed above. When pouring begins, the lower parts of the mould fill rapidly, but, when the heavier parts of the casting are reached, the general rise is slower, and may momentarily be stationary. The two streams rise and meet at C. If that moment should coincide with a rapid drain of metal to fill up brackets at that level, what might be called the lips of the converging streams may hesitate in that position. Hesitating and oxidising, they fail to coalesce properly at the lips for a depth of, say, ¼ in., but the oncoming metal rides over the top. This occurrence is explained by the gas-producing reaction which takes place. These castings are usually poured in 70 secs. through two in-gates, each 2½ in. by ¾ in. The casting under discussion took 78 secs., owing to the fact that the in-gates had been unwarrantably constricted in moulding.

This indicates that there are natural limits

to the slowness in pouring methods. Attempts have been made to rationalise this question by the production of formulæ relating time taken to pour to the weight of metal being poured. Such formulæ, however, can have no general utility, as they can only be applied in particular circumstances. As a rule, large horizontal surfaces should be covered as quickly as possible, though the design of castings frequently makes it difficult to determine suitable points of entry. With vertically cast moulds and small or lumpy castings greater freedom is possible.

Slow Pouring Conditions

Very slow pouring, in a few cases, is advantageous. The small gear blank shown in Fig. 23 is repeatedly cast cleanly and solidly through the pencil gate shown. This casting weighs 42 lbs. and takes 37 secs. to pour. A comparison of this with the pouring time of the casting shown in Fig. 17 shows the difficulty of stating any rule. One casting is 173 times heavier than

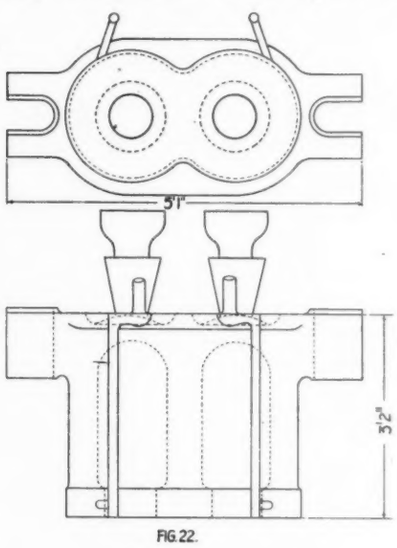


FIG. 22.

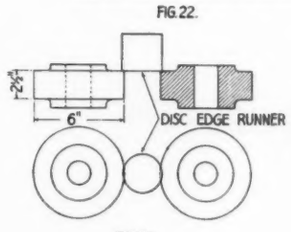


FIG. 24.

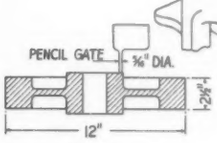


FIG. 23.

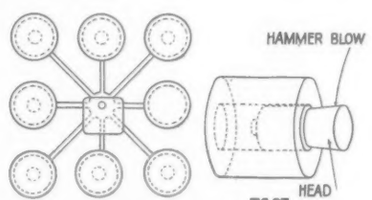


FIG. 27.

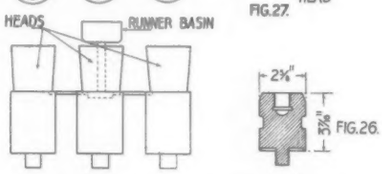


FIG. 25.

FIG. 26.

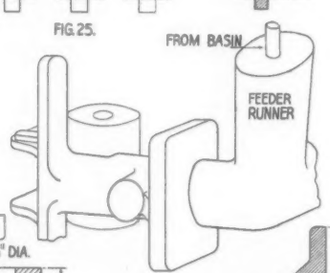


FIG. 28.

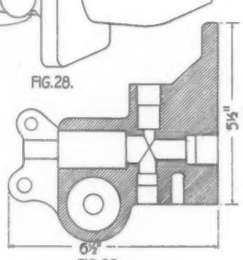


FIG. 29.

the other, but only takes twice as long to pour. The blank illustrated in Fig. 24 is equally good if cast through a disc-edge runner, though the pencil runner fails. Slow pouring, with a view to avoiding draw or porosity, is usually only successful if the metal is poured at a temperature which barely enables the mould to be filled.

In some cases it is advantageous to make runners comparable with those used in non-ferrous practice. In Fig. 28 is shown the runner arrangement for a small air valve, while a section of the casting is shown in Fig. 29. An awkward conjunction of body and bosses near the flange makes it ordinarily very difficult to get solidity for the valve seatings and tapped holes, but gating as shown in the sketch gives invariable freedom from rejections.

In-gates

In-gates should be truly in line with the casting sections entered, whether vertical or flat, so that the liquid metal does not impinge directly on the mould or core surface at the point of entry. Where the in-gate enters at a circular flange, its entry should be tangential. Observance of these rules will eliminate many scabs and reduce turbulence, which makes for unsoundness. Fig. 22 shows the runner arrangement for a double hydraulic cylinder weighing about 2¾ tons. It may be noted that the chief advantage of a tangential runner does not lie in its tendency to give the metal a revolving motion, for that is lost a few inches above the runner where it is running round a core, but in the fact that this type of runner has less tendency to cut the core surface and makes for better distribution. Where there is no centre core, the tangential runner will bring the dross to the centre, in position for entering the head should one be provided.

Functions of a Riser

Every casting must have a runner, but not every grey iron casting needs a riser, and the great majority of small grey iron castings made have no risers. Castings with pencil gates have no risers. The guard casting shown in Fig. 9 has none. Many castings are definitely better without a riser; but, nevertheless, the riser has important functions in grey iron.

It is, however, a convenience to know definitely when a large mould is filled, and in a mould of any considerable size which is cored, one or more risers should be provided in order to give an outlet for gas bubbles which may accumulate. Such risers should be in the regions at which bubbling may be suspected, and on the highest parts of the mould. When the top of a core or upstanding part of a mould is covered by molten metal, gas pressure inside the core or mould part may rise very quickly, and until the head of metal above the core is sufficient to counterbalance the gas pressure inside the core, gas will bubble through the rising metal. If the gas pressure inside a core rises too sharply (as is the case with an insufficiently dried or badly vented core) the metal may be blown out of the mould, gently or explosively. If a core continues to "blow" when a head of 12 in. metal is above it, it is clear that the gas pressure inside the core is more than 3 lbs. per sq. in. Whilst a mould is filling, therefore, some part or parts of it may be bubbling, and the metal stream, passing on and upward, may carry such bubbles safely away through the riser or risers. Many difficult cored jobs have been saved by the simple expedient of raising the height of the runner and riser heads a few inches, thus providing the necessary head pressure to force the gases in cores through the vents.

The bubbles referred to above are not in quite the same position as the air which is in the mould when pouring begins. The incoming metal readily displaces the contained air owing to its higher gravity. This air escapes easily through the pores of a green-sand mould, though perhaps not so readily through the blacking skin of a dry-sand or loam mould. The last two types are, however, all more or less cracked owing to varying expansions, when drying, of mould and mould materials, and subsequent cooling during assembly of the moulds does not close the cracks. These, together with the natural porosity of the sand, usually provide ample exit channels for the air with which the mould is filled before pouring.

Whistlers

The "whistler" is sometimes used to facilitate the escape of contained air from a mould during pouring, so as to reduce the resistance offered to the advancing metal in thin, upstanding or isolated sections in the top part. Its value is doubtful, for a small accumulation of gas is often found at its base and it has some of the disadvantages of the open riser. When a mould is filling, the contained air rises in temperature and, if it cannot by sufficiently quick exit find room for expansion, its pressure rises. At the same time, gas pressure and volume inside cores and upstanding parts of the mould is rising. If the gas pressure in the mould cavity is greater than that in the cores the gas of the latter will pass out through the vents. If it is less, some of the gas generated in the mould or cores will pass into the mould cavity, and find exit through a riser or whistler. This phenomenon has destroyed the usefulness of many otherwise good moulds. In green-sand moulds particularly, a rush of gas through open risers breaks away the mould surface in their vicinity, whilst the loss of pressure in the mould cavity may induce a pulling down of parts of the top, where large surfaces are concerned. In practice, therefore, risers are kept closed on all but the lighter castings. The lift of the ball, core or brick on the riser indicates that the mould is full.

It is sometimes urged that a riser helps to rid a casting of dirt as well as bubbles, but this is an illusion. Dirt usually remains firmly fixed to the first upper surface with which it makes contact, and no amount of "running through" will dislodge it. The writer has not yet found a single instance in which a riser, as distinct from a head, has removed dirt from a mould.

It often happens that the top part of a mould has a number of protuberances in the shape of bosses, lugs, brackets or flanges, and it becomes impracticable to put risers on all of them, and it is often useless and inadvisable to do so for they are better without. In such cases the dummy riser is sometimes resorted to, but its usefulness is very doubtful. It is not uncommon to find a bubble of gas at the base of such a riser and in the actual casting. The writer has not yet seen a dummy which contained dirt or a bubble, except at its base, where it has failed. A riser also reduces the pressure on the mould; this may or may not be advantageous. Certainly the riser can only reduce the pressure in the mould if its level is lower than that of the head of the runner basin.

An important use of the riser is for the purpose of feeding. In many cases an approximation to non-ferrous and steel practice obtains, *i.e.*, a heavy feeder head is provided which feeds naturally. Examples are shown in Figs. 16, 17, 18, 19 and 22, and every foundryman is ac-

quainted with similar examples. In the case of the double hydraulic cylinder shown in Fig. 22, a feeder head is provided over each cylinder, and the risers are also rod fed. The practice of natural feeding can sometimes be extended with advantage to small castings. Consider the small air-cylinder piston shown in Fig. 26, which, as cast, has the form shown in Fig. 25. These have been made in thousands without a single rejection on the following lines. They are made eight in a box, and the centre runner feeds a single spray to each casting, each having a riser or head as shown. Pouring is continued until the heads are full. When cold, each in turn is slipped into a heavy cast-iron sleeve, leaving the head projecting, as shown in Fig. 27. The heads are broken off with a forehammer, and the castings are then thrown into the rumbler, after which they are turned, bored, tapped and screwed without disclosing any defect.

Rod-Feeding

Risers for rod feeding often give disappointing results, because they are made too small. A 7-in. cube cannot be fed through a 1-in. dia. riser. Such a case would require a 2½-in. dia. riser at least, but, given a riser of the right proportions, the feeding can be nugatory. It is sometimes suggested that rod feeding simply

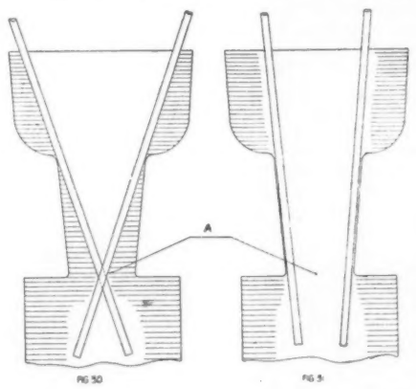


FIG 30 FIG 31

consists in keeping open the riser so that liquid metal may drain into the cavities forming below. This is quite true of the earlier stages of the feeding, but the really crucial stage in feeding is when the metal in the riser and adjacent casting has entered the pasty range between liquidus and solidus. Feeding is at all times hard and exhausting work, particularly on heavy jobs, and calls for a high degree of conscientiousness on the part of the man feeding. When the pasty range is reached, he is strongly tempted to "feed it up," but this usually results in a premature withdrawal of the rod by an inch or more at a time. Very soon he finds himself feeding the riser only, the metal below being solid. The casting, however, which the rod has not fed is still liquid, and a hole is left underneath the riser. The feeder, at the commencement, should dip his rod, usually, not more than three or four inches into the casting and keep it pumping at that depth, not coming higher until he has solid metal below his rod; then he may withdraw it as the solid grows below. If this practice is not followed, gaps may be formed when the metal is in the pasty range, which are bridged over.

Another difficulty arises from the way the rod is used. The man feeding may realise that the hole must be kept as big as possible, and consequently works his rod round as shown in Fig. 30. The head remains quite open at the top for a time, but soon, at the point A where the riser joins the casting, he is trying to feed through a hole little bigger than his rod. In a case like this, fresh supplies of hot metal are of little avail. The right method is shown in Fig. 31, the rod being carefully worked down the sides of the hole all round. Only thus can the job be fed solid.

Small Steel Furnaces

It is probable that the majority of engineering firms who maintain their own iron and brass foundries do so not so much in order to obtain their castings at a lower price than would be possible if they were bought from jobbing foundries, but because they believe that only by having a foundry under their own control can they ensure the service that their machine shops require. A steel foundry is found less frequently, not because the desire is less, but because the demand for castings rarely justifies the cost of installing an electric furnace or a converter.

A type of steel melting unit which has not perhaps received the consideration it deserves is a coke-fired pit-furnace which can be installed in a corner of the iron foundry and operated by the normal foundry personnel. Such a furnace would appear to be of outstanding interest in this connection, particularly as its low first cost and simple method of operation enable steel in small quantities to be melted at an all-in charge barely higher than that obtainable with large scale furnaces. Moreover, such a furnace is extremely flexible, and suitable not only for straight carbon steels of various tempers, but also many types of alloy steel, steel mix and the special heat- and corrosion-resisting irons.

It is extremely simple in design, consisting only of a large forced-draft pit-furnace square in section, usually taking four crucibles at a time. A popular size is that which takes crucibles each holding 80 lbs. of steel, and by using the modern "Rapid" crucibles three heats, equal to a total of 960 lbs. of steel, are obtainable in a working day. The crucibles can be drawn from the furnace with the aid of a simple swinging lever, and the operation is so quick that all four crucibles can be teemed into one casting if so required. By using larger crucibles the weight of steel available per round can be brought up to about 480 lbs. The steel is deoxidised by adding about 1 oz. aluminium to each crucible immediately the pots have been drawn from the fire.

For ordinary medium-carbon engineering castings the crucibles are charged with scrap mild steel, usually in the form of punchings, and the resultant steel has a carbon content of approximately 0.35 per cent. This can be reduced by additions of wrought-iron scrap or increased by additions of high-carbon scrap, such as old files. The majority of the special alloy steels can be made without trouble by suitable additions of nickel, chromium, tungsten, etc.

Most makers sell crucibles specially devised to withstand the high temperatures involved, and the best makes will usually give a regular life of at least eight heats of mild steel, increasing up to fifteen or more with the easier melted steels. The crucibles normally tend to wear thin externally by the action of the ash of the fuel, and experience has shown that Durham or Welsh furnace coke gives the best results. With charges consisting of punchings the coke consumption is about 125 per cent. of the weight of the metal melted during a day's work of three rounds.

Furnaces of this type are lined with stock firebricks, and the shape of the lining is simple, requiring little skill to replace when worn out. The duty is severe, but a first quality Scottish aluminous firebrick will be found to give excellent results. One man can operate the furnace with the assistance of another when the pots are ready to pull out.

As a guide, the following table summarises the approximate cost of melting a ton of steel by this method:—

	£	s.	d.
Steel punchings at, say, £3 15s. per ton	3	15	0
Coke at, say, £2 per ton	2	10	0
Crucibles, etc.	2	16	0
Linings		6	0
Labour	1	8	0
Fan power at 1d. per unit ...		2	6
Total	£10	17	6 per ton of molten steel.

The capital cost of a four-pot furnace complete with blowing fan and accessories should be well under two hundred pounds.

High-Duty Alloy Cast Iron

(*Concluded from page* 267.)

Rotary Furnace Practice

For small castings rotary furnace melting appeared particularly advantageous, since inoculation could be carried out inside the furnace and maximum possible temperatures obtained. Calcium silicide certainly seemed to have some special properties and gave good results when used as an inoculant. Current views on inoculation are, however, in a state of flux and the presence of calcium was probably helpful in its effect on non-metallic inclusions, which was, according to some authorities, the basis of the inoculation treatment.

Replying to Mr. Brown, Dr. Everest agreed that, compared with other foundry materials, nickel was expensive. Mr. Brown's comment, however, was admirably supported by the fact that, in spite of its cost, nickel was used extensively and there was probably to-day not an automobile on the road which did not contain at least one casting in nickel cast iron. Dr. Everest agreed that, owing to their short freezing range, special precautions in running high-duty cast iron castings were necessary and large runners and risers were required. With ordinary care, however, there was no great difficulty in producing sound castings even in quite complicated shapes.

Dr. Everest emphasised that, whilst the Ford crankshaft material might technically be considered a cast iron, the point he wished to make was that it was very different in composition and structure from the more ordinary cast iron alloys being used for crankshafts by other manufacturers. The presence of graphite alone in a material did not make it a cast iron, since, as was well known, it was possible to find free graphite in heavy alloy steel forgings where the heating had been excessive. With reference to the question of a definition of cast iron, the field of cast iron generally had been very much enlarged by the development of modern high-duty irons, and it would certainly appear desirable to consider the position with regard to definitions at the present time. He felt that the difficulty he had experienced in defining high-duty iron should be officially recognised and some proper definition evolved before the term became misused, as was the case with semi-steel.

Spectrum Analysis of Alloy Steels

The technique of spectrum analysis in which the specimen under test undergoes no change owing to the use of a copper auxiliary electrode, for the quantitative estimation of the alloying components of iron and steel, is described by O. Schliessmann and K. Zänker in Report No. 117 of the chemical committee of the Verein deutscher Eisenhüttenleute published in the "Archiv für das Eisenhüttenwesen." It is shown that the carbon content also can be determined semi-quantitatively in simple alloy steels by resolution of the spectrum in the large uni-prism spectrograph. Silicon, manganese, nickel, chromium and molybdenum are estimated from the spectrogram by selecting suitable pairs of lines and plotting the reference concentration curves. The method is also applicable to high-alloy steels, its overall accuracy being of the order of approximately ± 5 per cent. The calibration curves can be employed for the analysis of actual melts, the results being in satisfactory agreement with those obtained by direct chemical analysis.

Heat-Resisting Muffle Equipment*

By A. L. FAWKES

The consideration which this subject has received by vitreous enamellers emphasises that in this industry, equipment which in some trades may be regarded as a detail only, reflects the efficient nature of the enamelling industry. It will, therefore, be of some interest to summarise briefly current practice of supporting ware during the fusing of vitreous enamels.

It is hardly necessary to dwell upon the rapid and effective improvements made during the past few years; furnace construction has developed with the resulting conservation of fuel and labour costs and ensuring much greater efficiency. Charging apparatus has been modernised and the introduction of heat-resisting alloys has received perhaps greater recognition by enamellers than any other branch of industry. Collaboration between enamellers and producers of heat-resisting alloys has grown during the past few years, and the development of understanding of difficulties on both sides has led to the more efficient fusing methods of to-day.

In this country enamellers are at present concerned with perrits and frames supported by the floor itself in box muffle fusing, but American practice inclines one to the belief that each and every article for fusing entails its own particular jig or frame, the impression probably arising from the requirements of the continuous tunnel furnace. The industry has grown on different lines in Great Britain, where the batch or box muffle has maintained favour and the tendency has been to employ existing designs of perrits or minimise changes on those which have been proved to meet all general requirements economically.

Perrits

The saw tooth, half oval and triangular perrit shapes have been considered satisfactory since the earliest days, and it is of interest to state that the saw tooth or notch bar was first used by a Birmingham sign maker, nearly sixty years ago. In any case, a great proportion of enamelware fusing is still carried out on the original principles, and it is not suggested that when first nickel chromium heat-resisting alloys began to replace iron perrits, they were anything other than a refinement, and the change did not take the enamelling trade by storm. The change in this country has been built up on successes in practice and publication of authoritative details on heat-resisting alloys generally, the study of which has led to a basis for alloys for fusing, of some 50 to 70 per cent. of nickel with 15 to 20 per cent. of chromium. This basis is possibly arrived at from the facts that trimming and finishing costs are no higher with high-grade alloy than with low-grade, and that strength at high temperature is the essential feature.

Weight of Perrits

The weight of perrits and fusing jigs is an important factor, and the economics of the matter may be put forward on the following simple considerations, but must not be confused in any way with the American continuous furnace practice. An average weight for saw tooth perrit with usual double side is 2¼ lbs. per foot, but it will be appreciated that castings can be produced much lighter or heavier. Under general usage the very light perrit of, say, 1⅛ lbs. per foot is rapidly destroyed owing to the breakdown of the points by local heating and the fluxing effect of borax as the metal of the body or rails is not sufficient to conduct the heat away effectively. The converse is the case with a very heavy perrit, and unless the weight of the ware is such that the proportionate weight justifies it, the value of the extra length of life is offset by the extra heating costs.

For the fusing of medium sheet, the perrits may weigh roughly five times that of the ware for economic working, but for cast iron the proportions may be almost reversed so that over a similar area the weight of a load of cast iron may be about 20 to 25 times that of sheet ware.

Hanging Supports

The hanging support, which was essentially of cast nickel chromium alloy, was first employed in this country eight years ago; the first frames which were made went directly into commercial use and immediately following this the numbers multiplied many times and during the following three years found general adoption. Development of design, usually with a view to fusing miscellaneous ware, was also very rapid, but it is of interest to record that the firing of cooker fronts and frames, for which the hanging perrit was originally made, is still carried out in exactly the same manner to-day, in fact, a number of the original nickel chromium base frames are still in daily operation. It may be judged that the atmosphere itself in an enamelling muffle has only a very slow destructive effect on high-grade heat-resisting alloys.

Mechanised Movements

As employed in normalising steel sheet, a moving hearth might be constructed of such substance that maintenance costs would be very low, but this may be disregarded on account of heating costs, scarring ware, etc. The alternative to a moving hearth is the continuous tunnel or muffle, wherein the ware is propelled in a correct cycle of heat by means of suspended perrits which are actuated from an overhead track above an open or closed slot in the roof. This system is a practical proposition to say the least, and will probably obtain certain favour in this country in shops where a heavy output of general repetition work is constantly maintained.

American Practice

One of the outstanding developments in the industry of the present time devolves very largely upon heat-resisting alloys, as the continuous muffle would not be operative without the use of heat-resisting carrying frames. In this field the American practice has generally tended to the use of medium grade alloys, but owing to the little difference in comparative initial cost in Great Britain, the higher grades will continue to find favour in accordance with established practice. The reason for this lies in the fact that whilst alloys containing below 45 to 50 per cent. of nickel with moderate carbon content are comparatively easy to produce as light frames such as required for double-deck fusing of sheet and light castings, the temperature strength is such that it is easy to overload too heavily with resulting collapse. With the most careful designing, with angle brackets, even sections, light welding, etc., distortion takes place and it becomes necessary to straighten the frames, but often twelve months will see the useful life completed and the frame will break on any attempt at straightening. For the most part it is the constant heating with rapid cooling which causes eventual breakdown of heat-resisting castings and a weak spot may result in scrapping an otherwise sound frame. The remedy for this lies in the frame being of composition which allows for perfectly sound welding; that is to say, alloys of which the crystalline structure is stable after prolonged heating.

Repair Considerations

When using continuous furnaces, necessitating a wide range of jigs varying from small trees to large perrit carriers weighing up to a hundredweight or more, it may well be foreseen that much expensive trouble and anxiety will be avoided by using alloys which do not grow or embrittle and may therefore be repaired with ease and certainty. Apart from these considerations is the even more important one of employing nickel chromium castings as near their limit of viscosity as practicable, and it is somewhat surprising to realise that a large proportion of perrits and frames are strained throughout their lives by carrying loads above their true limit of temperature creep strength. To work within the true strength compass would often show the casting to require sectional thickness well in excess of that of the casting which practice has proved to do the work required of it in fusing operations, and this proves that previous experience is usually the best guide in designing frames and carriers.

Strength at Elevated Temperatures

In an appendix to Volume I of "Industrial Furnaces," Trinks sums up as follows:—"At high temperatures metals and their alloys possess a definite load carrying ability which will, within definable limits of temperature and stress, be accompanied by deformation so very small that it may be disregarded for all practical purposes."

The position is anomalous, in so much that alloy producers are called upon to produce castings which for reasons of efficiency and economy are very much lighter than the work would appear to necessitate, but the user will agree that this can be taken too far and apparent economies are only pitfalls, and, as shown earlier in the case of saw tooth perrits, weights and service are by no means to be considered in direct proportion.

When one examines the position carefully, it becomes clear why so little standardisation is possible for perrits and frames, although superficially it might appear that there is a great deal of waste incurred by failure to standardise. For instance, almost every practical enameller has his own preferences for perrits or frames for firing a particular job, or gauge or size of sheet and quite justifiably continues to adhere to his preference as an initial economy may be lost very quickly by fusers who are unused to the new type of perrit.

* Paper read before the Northern Section of The Institute of Vitreous Enamellers, Mr. H. Whitaker presiding.

Design of Perrits

In any case, it is obvious that in the large shop producing great quantities of varying articles, any change must be approached more cautiously. A few years ago there was a predilection for perrits with high spikes about twice or three times the height of usual perrits, the idea being that the enamelled sheet would benefit by the quicker absorption of heat, and in some measure the principle has much to commend it.

Shop usage has shown the benefits to be limited, as also the Continental method of pushing spikes into a drilled base rail; very little is seen of this principle to-day, as the spikes were often found to scar the ware badly or to pull out, the fusing not confining itself to the ware only. An improvement which has become soundly established is the chisel edge on the ordinary saw tooth bar; with certain enamels which tend to "gather" during firing, the edge is not suitable, but a sharp edge is readily obtained by grinding the sides.

Weight Reduction

In passing, it should be mentioned that for sheet work with deep edges or bends, spike perrits can be produced of practically any desired height, so that fouling of the floor or the base rail is avoided, although several alternative methods of fusing present themselves. The double upright frame with straight vertical members, originally designed in wrought iron about forty years ago for sign work, has given rise to a number of modifications, branched uprights will usually accommodate any edged plate, and on quantity the muffle space saving is considerable, and the comparative weight of the perrit to sheet may be reduced to roughly three to one. A modification of the hanging frame which is open to development is the spike or toothed top bar type, from which can be hung open frames of cast or sheet material far more than the weight of the support itself, the only deterrent to its full employment being the steadiness of the charging fork in avoiding the ware from scarring in loading into the muffle. The question of the charging fork is one which has been adequately met for the trade, and whilst hand forks still meet the need for the smaller muffles, the mechanical fork of to-day is a great asset, and by reason of its strength and rigidity of operation enables deep muffles to be charged safely and fully.

A rough estimation of a 12-ft. deep muffle load of cooker fronts will show a weight in the muffle of about 15 cwts. and even a higher figure with the annealing charge. Compare this figure with a load of sheet; an approximate weight of two to three hundredweights includes ware and perrits, and proves clearly the consideration which is required in designing fusing jigs now that the charging feature is established.

Heat Absorption

In the first approximation the weight of the jigs will represent only one-third of the heat absorbed, whereas the latter shows about two-thirds heat absorbed by perrits, except when extremely rapid re-loading is possible in which case, the perrits are recharged whilst still holding considerable heat. Appreciation of this wide variation has been shown by enamellers throughout the country and many designs of jigs are now available to meet particular requirements, and the producers of heat-resisting castings are doing their best to collaborate and assist in improving efficiency.

As typical of the wide variations of requirements encountered, there are two sets of frames working side by side, the weight of the one unloaded being about three times that of the other set fully loaded, both are equally efficient by reason of the differing types of ware carried by each, and serve to illustrate the detail which must be mutually understood in originating a design.

To indicate the wide range of frames employed to-day on in-and-out fusing there is the rigid double deck, the light double deck, the hanging frame, the coat hanger, the double upright branched and vertical, and the rigid single deck. Each type has many variables, that is, for length, height, capacity and rigidity (*i.e.*, for steadiness in charging or for load-strength) and a recently produced casting in 70/20 per cent. nickel chromium (which for brevity the writer would suggest terming "a rigid single deck") is a channel ring weighing about half a ton, this of course being proportionate to the work.

Consider the rigid type and light type double-deck frame. In the former the perrits carried on the bottom are supported by the bottom rails of the frame itself, whereas in the latter the bottom layer of perrits is picked up by the charging forks and rest on the floor of the muffle. The second method allows of a much lighter frame and is readily applied for light small ware, but the rigid frame provides for all classes of ware and is extremely durable and gives long service. The coat hanger frame derives its name from its appearance and has much to lend it favour, as in cases where sheet or light castings can be hung through stamped or cored holes by means of thin cast hooks or wires. A high arched muffle is essential with this type of frame otherwise the sizes of sheet which can be fused vertically is very limited, and the benefit of this method of firing is lost.

Saw tooth perrits or half ovals may be carried into the muffle under the coat hanger frame, and accommodate addition to the charge, the regular disposition of ware throughout the muffle making this method attractive where circumstances permit. The frame capable of supporting the greatest proportionate loads is undoubtedly the hanging perrit where the work to be fused (or annealed) will enable its use to full capacity. This type of frame was referred to earlier as an original design from which so many have developed. It consists of two parallel base rails with uprights welded at their centres, and the uprights carry top arms directly in line with the base, the whole being held rigid by cross strips welded either side; general overall dimensions are: 4 ft. 6 in. long (*i.e.*, to suit width of muffle) by 1 ft. wide by 1 ft. 6 in. to 2 ft. 6 in. high (according to height of muffle to the spring of the arch). It will be appreciated that the strain at the ends of the elevated support bars may reach many hundreds of pounds per sq. in. when fully loaded, at fusing temperatures, and such bars must be capable of being maintained horizontally (or at any rate by periodical reversing). It is essential that the nickel chromium alloy must be of very high creep resistance, otherwise collapse will be rapid.

The double upright frame was an early design in its simplest form, and heat-resisting alloys have made possible many refinements, four point contact is all that may be necessary with flat plates, and slotted sheets can be fired with the very minimum number of points of contact. Slotted sheets up to 2 ft. long by 18 in. wide can be fused with only nine points of contact, the ware resting at an angle of about 60 deg. does not become buckled as the verticals can be branched in such manner as to provide support at essential points.

Triangular Bars

Triangular section bars are produced in great variety from ¼ in. width on the side to 2 in. on the side, with the larger sizes weight is minimised by "scooping out" the section. Above the latter size the triangular bars are cored through the centre, and castings up to 8 in. triangular by 10 ft. long are in service with satisfactory results. For supports such as bath rests heat-resisting castings have very largely replaced iron and, perhaps, singularly in this work, the economics of the case prove the nickel chromium casting is cheapest in service, when little or no attempt at "lightening" compared with iron is made, except when the rigid single-deck frame has to extend the full length of the ware.

In the heavy class of vitreous enamelling such as tanks and covers, the supports assume considerable dimensions as the loads to be supported are usually of many tons on each firing and the collapse will mean a heavy loss. Development in this field has of necessity been cautious, early errors arising from the failure to allow for expansion force against downward pressure, and from the fact that heat penetration does not take place perfectly evenly.

Modern Developments

The past ten years have seen great strides in the technique of fusing vitreous enamels, the "wet process" as applied to cast iron opened the demand for differing types of fusing supports, and many tons of heat-resisting castings are absorbed annually by vitreous enamellers on trade requirements. The height of enamelling muffles was essentially more than required by the layer of ware itself, but vertical fusing put a different aspect on this, and muffles are now built with a view to accommodating increased height of work. Attempts have been made to tier fusing more than double decks, but owing to the increased weight of the fusing frames, out of compensation with the double frame, this is not yet practicable except by layering triangles and cross bars. Regarding the fusing of large numbers of identical parts, economics will usually prove that the jig should be made definitely for the purpose, and the result will be a better finish at a lower cost. As an instance, reflectors vary in diameter from some 3 in. to 3 ft., and it is not to be expected that the same jig will support any diameter, nor even that the same principle of support will hold good.

A small diameter disc needs protection from distortion and must be supported to this end in the furnace, whereas a large diameter domed disc needs very little protection, but must not show a large number of fusing scars, therefore the opposite consideration arises. A further instance of widely differing essentials is presented in the enamelling of cylinders. One of the simplest fusings is of very light sheet cylinders (supported on light triangular bars), whereas, one of the most difficult is that of heavy gauge cylinders, on account of the time required in the muffle and the tendency for the steel to bend over during the firing.

All double sided enamelled ware presents its own particular firing problem, and when the day arrives that all ware can be "held by the hole in the handle," the enameller will have much more leisure time than he has now.

Essential Properties

It is not proposed to discuss nickel chromium alloys, except where they directly interest the enameller under the heading of "heat resisting muffle equipment," and the following may summarise the desirable qualities of alloys for the purpose.

(1) The metal of the perrits or frames must resist scaling at temperatures certainly not less than 1,000 deg. C., and the oxide must be strongly adherent with the most rapid alternate heating and cooling.

(2) The strength must be such that the temperature of operation does not result in deflection under load beyond economic weight—load ratio.

(3) The alloy must accommodate any warpage due to speeding up of fusing probably causing overloading during service. This may be rectified periodically by straightening and welding if necessary.

(4) Where constructed frames entail welding, the alloy must be of composition which ensures that the strength each side of the weld is equal to that of the weld itself, and the resultant alloy of the weld must conform with the non-scaling properties of the casting.

The surest approach to the correct use of heat resisting alloys is by the elimination of the unfit, and both users and suppliers are desirous of establishing working principles which will be of service in the constantly growing industry of vitreous enamelling.

As for the future, every confidence is held in this country that the requirements of the trade can be met by heat-resisting alloys of quality unsurpassed in the world.

In conclusion, the author would express his deep appreciation to his director, Mr. S. W. G. Snook, of the Cronite Foundry Company, Limited, by whose permission this Paper is published.

DISCUSSION

The Chairman (Mr. H. Whitaker) thought the perrit bar was one of the details of the vitreous enamelling shop which did not receive as much attention as it should, although it was a deciding factor in the production of a good job. It was very difficult for the jobbing enamellers to discover a perrit bar which was suitable for every job. He would be glad to learn how the term "perrit" originated, as not even the standard dictionaries stated its derivation.

Continuing, the Chairman asked whether double-decking really paid in the long run for such components as were required, say, in gas-cooker work. He was acquainted with at least one well-known enameller who still advocated single-decking.

Mr. Fawkes considered that the value of double-decking could hardly be questioned. It was now in actual operation in some of the largest works. The practice had its limitations, however, and with certain work was not the best method to adopt. For instance, in the case of cooker fronts supported on the rigid double-deck frame, the frame weight was nearly double, and the time taken was nearly treble that when using the double-support-bar hanging frame. With a muffle which was not particularly high, the double-deck frame certainly had a very considerable advantage over the coat-hanger type, which was its nearest rival, because there was much ware which could not be conveniently held through holes. The very light double-deck bar was extremely useful for miscellaneous ware, such as the tops of gas irons, which could be put upon it. It was possible to put on perhaps sixty in a single firing on a double-deck frame; consequently there was a direct ratio of 2 to 1 over flat firing, less the slight additional weight.

Adjustable Perrits

Mr. J. H. Gray inquired whether the adjustable hanging perrit was really necessary. He knew several plants in which they were operating, but owing to the long time they had been in use the bolts had scaled up, and were not removable. He knew also of a number of plants which had non-adjustable perrits which appeared to work satisfactorily. They were cheaper to manufacture, and, of course, would be cheaper to the purchaser.

Mr. Fawkes observed that the original design of hanging frame was adjustable; but it was not realised when they were originally designed how much they would be used on one particular job. Consequently the principle adopted was to take varying widths of cooker fronts. Then the number of cooker fronts multiplied but no adjustment was necessary, and it was only in smaller shops that the adjustable frame was essential. Generally speaking, in the case of the large shop the frame was fixed and remained in a fixed position. It was very seldom that one was altered, which was actually an asset, because nickel-chrome bolts had a tendency to seize on heating. For a reasonable length of time bolts might be undone, but after a period of about six months use they often snapped or the thread was spoilt.

Welding

Mr. A. Connolly asked what alloy the lecturer recommended for welding.

Mr. Fawkes considered that there was one alloy which was entirely suitable, namely, a straight 80/20 nickel-chrome. It was expensive, but enabled the welder to effect a much better job, and the extra cost was saved in the quicker operation. The metal under the flame did not, to use a welder's term, "go like sand." Nickel when alloyed had a tendency to oxidise, and consequently made a poor joint. He was afraid that in the case of electric welding the rod was as yet somewhat expensive, but a coated 80/20 nickel-chrome was now obtainable, and was the most suitable material to use once the welder had become skilled in its use. Welding could even be done by breaking off a piece of perrit and welding it on the break, but it was not satisfactory. It was inadvisable to use a wire of less than $\frac{3}{32}$ in. diameter, otherwise the metal oxidised so rapidly that a doubtful weld was formed, and in any case care had to be exercised to minimise the amount of oxygen when acetylene welding nickel-chrome alloys.

Mr. J. H. Gray inquired whether Mr. Fawkes could state the weight per foot of perrits for sheet iron, compared with the weight per foot for cast iron. What did he recommend in regard to the saw-tooth perrit?

Mr. Fawkes thought that the weight for saw tooth perrits ought to be approximately the same for sheet or cast work. The temperature developed rapidly, and it was possible to destroy a perrit-firing sheet much more readily than when firing cast-iron ware. If a perrit were of good substance, it helped to preserve itself, in so much as the heat was transferred from directly underneath the sheet. The conductivity of nickel-chrome being very low, any substance forming on the point itself tended to become incandescent; therefore only a fairly stout bar would be sufficiently conductive to transfer the heat. The question was hardly one of comparative weight considerations, except that instead of weighing, say, 2¼ lbs. per ft. the perrit bar might be reduced to 2 lbs., but below that weight the points were prone to much earlier destruction.

On the motion of the Chairman a hearty vote of thanks was accorded to Mr Fawkes for his Paper.

Costing in the Vitreous Enamelling Industry

In our last month's supplement we published Mr. J. Pedder's Paper, "The Elements of Costing with Reference to Vitreous Enamelling," which was presented to the Southern Section of The Institute of Vitreous Enamellers. The interesting discussion which followed was opened by the Chairman (Mr. V. C. Faulkner), who asked what the author's method was of proportioning the overheads of the various departments over the various jobs. Many industries, he said, were allocating such charges on the basis of the amount of floor space occupied by each job.

Discussing the practice in some industries of adopting a standardised costing system which all the employers in each industry pledged themselves to use, he mentioned the interesting example of the German ironfounders, who had developed a system which, when applied, was found to increase the price of the castings that were being supplied to the railway companies. The railway companies had objected to the new price and had sent their actuaries to ascertain the true costs. The figures arrived at by the actuaries as the result of their research when graphed lay centrally between the curves which were developed by the ironfounders.

A Simple System

Mr. J. H. Coupe (hon. secretary, Southern Section), who advised against the adoption of too elaborate a system, the cost of operation of which sometimes outweighed the benefits derived from it, said that the very simple method adopted in his company's foundry was to check the castings when they came from the foundry into the store and to credit them against the moulders individually, each of the moulders being numbered. Then, by dividing the weight of castings into the total amount paid in wages, a labour cost per lb. of casting was arrived at. The system was very simple and efficient, and did not entail any complicated bookkeeping. He appreciated, of course, that in other circumstances it was necessary to make more detailed analyses of costs, but he felt that in many instances costing was being overdone.

Machine Hour Rate

Mr. D. Pearson said that although the author had stated that he had refrained from elaborating methods of analysing wages, materials and expenses, works routine and statistical presentation of results, and despite the fact that each of the various sections mentioned were worthy of a Paper on their own, one felt that he had not dealt with the job cost in the most economical manner. For example, under the heading "Fritting" items such as wages, fuel consumed, wear and tear of kiln had to be calculated separately for each batch of frit melted.

The costing system developed by the Institute of British Foundrymen was based, in the main, on the American machine hour rate method and could be admirably applied to vitreous enamelling; he said that the rates could be set at the beginning of a year or any other period, for, say, a muffle. Matters such as heating, lighting, etc., could also be taken into account and dealt with as direct overheads. The costs for heating and lighting could be allocated by arriving at the total yearly out-of-pocket expenses from office records, and the shop split into floor areas, or the area occupied by each of the muffles or other plant, allocating to each muffle the actual cost per hour for the heating and lighting. The usual method was to take 50 weeks per annum, and 40 hrs. as an average week, so that the number of working hours per year was 2,000.

From the foregoing one could arrive at the hourly cost for that particular overhead. The costs of wages, depreciation and repairs and other similar factors could be dealt with in exactly the same way. The machine hour rate was ultimately the sum total of the various items, and a really accurate cost could be obtained for that particular machine.

Assuming, for example, that one was ascertaining the cost of a batch of frit from a melter which was being operated by two workers, the total time could be multiplied by the machine hour rate, thus obviating the necessity for repeatedly going into details of wear and tear of kiln, etc., separately for each job. In this way a considerable amount of work could be avoided. Another advantage was that if in the case of a small job, such as a small box, which was to be enamelled, time taken over enamelling could be measured, furnace loads could be calculated from the surface area of the furnace, and the quantity of boxes could be ascertained. Thus, by tracing the job through the works it would be possible to get a definite cost for that job very easily with the aid of the machine hour rate. At the end of the process, profits, etc., could be added and coupled with the statistical presentation of results, and it would be possible to ascertain whether or not one was working economically.

(*Concluded on page 278.*)

5724

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18 OUT OF TWENTY SIX

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● **THERE IS NO COLOUR IT WILL NOT DEVELOP.** Used with light shades of oxides it has been found possible to produce good work with one coat direct on cast iron. It possesses an excellent gloss and covering power, being particularly good for use on poor castings. One of our customers says :—"We should like to state that this is the only Frit we have found capable of developing the large and varied range of colours used in our industry . . . . . up to date we have found no colour that it will not develop."

Founded 1870.

We at Blythe do all in our power to ensure consistent performance of our materials, and 5724 is typical of our highest standard of quality.

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B 8

With regard to the bonus systems, it is not quite correct to say that the "Weir" system gave 33⅓ per cent. of the time saved. At one time the "Halsey" and the "Weir" systems were coupled together, the "Weir" system being a slight variation. On the latter system 50 per cent. of the value of time saved was given to a highly skilled worker, and 33⅓ per cent. was given to a labourer, so that the percentage varied in accordance with the skill of the workman concerned.

Mr. T. J. Tovey pointed out that the Paper was concerned purely with costing of new work, and he asked how the author would deal with renewals.

Furnace Operations

Mr. J. H. Coupe, discussing the costing of furnace operations, for example, where the furnace was capable of fusing a certain load of articles per hour, said that the basis of the costing system depended largely upon the variety of enamelled articles being produced. It was obvious that where only one type of article was being enamelled for long periods, a definite number could repeatedly be fused at the same cost. Where, however, one had to deal with a variety of articles in a furnace, one's calculations would be entirely upset if one tried to adopt the time basis.

Referring to the author's example of a manufacturing and trading account, in which the figure for the materials used was given at 34.2 per cent., Mr. Coupe said he assumed that the author was referring to enamel frits, and he pointed out that the figure for materials must depend largely on the class of manufacture. In the manufacture of some articles, the raw material figure should not exceed 27 per cent., otherwise no profit would be made.

AUTHOR'S REPLY

Mr. Pedder, replying to the discussion, said that the method of allocating overheads depended entirely upon the nature of each of the overheads. Floor space was a suitable basis for rent; rates and taxes and cubic capacity formed a suitable basis for heating apparatus. In respect of lighting, it was possible to arrive at a direct charge, because the consumption of the lamps used in any department and the periods during which those lamps were used were known.

Standard costs should not be confused with uniform systems. In the foundry and some other industries an endeavour had been made to evolve systems applicable to the various works in those industries, with allowance for modifications to suit particular circumstances; no one system would fit any and every works, for there were too many variable factors.

Foundry Costing

As to the costing of castings, the method mentioned by Mr. Coupe was applicable in cases where all the castings were simple and did not involve intricate coring. In many foundries, however, the castings to be made varied, some of them being intricate and involving the use of multiple cores, and in such cases one could not adopt the simple system of dividing the tonnage of castings into the total cost and arriving at an average cost per lb., cwt. or ton. The costing of the continuous production of flat plates, say, 1 ft. sq. and 1 in. thick, was a different proposition from the costing of cooker castings, for example.

Standard Cost System

The allocation of furnace costs by calculating beforehand what the output would be was really standard costing, which was first evolved in America and had been developed rather extensively there. One first decided what the expenses should be and then tried to keep the actual expenses below that figure. In the Paper he had defined "standard costs" as "the basic economic cost of producing an article or carrying out a process which can be used for measuring the degree of efficiency shown by actual costs." From past experience, it was possible to form some idea of what a plant was capable of producing, and variations indicated whether or not the works were operating at standard. In some firms, a good many years ago, when standard costs were first considered, the relation between expenses and output was considered, and any variation on either side was regarded as a manufacturing profit or loss. It involved much work, but was of no benefit, because one could get the information from the records of the trading periods in the ordinary way. The systems he had described in the Paper were simple and served to show what could be done; there were many variations of them, to suit the particular conditions to which they were applied.

As a basis for estimating, one obtained information from the cost department. From the statements produced on the manufacturing side one could estimate what proportion of the total cost of the finished goods materials constituted, and wages and other expenses could be dealt with in a similar manner. The safest method of estimating was to use as a basis the item which constituted the largest part of the cost of the finished product; any slight error on that was in total less than the same percentage error on a smaller item of the cost. For example, if there were an error of 1 per cent. on 66 per cent. of the total cost, it amounted to only 1¾ per cent. of the total cost, whereas if there were an error of 1 per cent. on a smaller proportion of the total, the actual amount of the error on the whole job would be greater.

With regard to the costing of renewals, as distinct from new work, Mr. Pedder said that one could commence the costing process anywhere. For example, if one were re-enamelling a hob, one need not start with the price of frit from the raw materials.

Replying to Mr. Coupe's remarks concerning the loading of furnaces with tiered perrits, he said the matter was arbitrary. The greater the load, the greater the time required to fire it, and that was reflected in the furnace hour rate. With varied articles, the output per furnace would be very much less than if the articles were all of regular size and were loaded and unloaded at regular intervals of time. The figures used in the examples given in the Paper did not represent anything particular, but were merely used to illustrate the principles under discussion.

Vote of Thanks

The Chairman, proposing a hearty vote of thanks to the author for his Paper, urged manufacturers not to allow their sales prices to be influenced unduly by the statements of buyers as to the terms on which they bought from other manufacturers; it was often preferable to trust a competitor rather than a purchaser. The vote of thanks was seconded and carried with acclamation.

Metals to Withstand Fused Borax

The Chairman presented a letter, the writers of which had asked if the Institute could suggest a metal or alloy which would withstand the action of fused borax.

Mr. W. Thomason, F.I.C., suggested that if one used a metal which did not readily oxidise, the effect of the borax would be reduced.

The Chairman asked if he would suggest the use of stainless steel.

Mr. Thomason replied that one could use stainless steel or some other chromium alloy. He imagined that if borax attacked a metal it would do so through the oxide, and, therefore, if one used a metal which did not oxidise readily, one would overcome the difficulty. In reply to a suggestion that aluminium might be useful, he said that it was too soft, and would melt at a temperature even below the melting point of the borax.

Mr. Pedder suggested that the crux of the problem was the length of time during which the fused borax would be in contact with the metal. Platinum was, of course, the ideal metal to use, but this might not be practicable.

Piece-Work System for a Fettling Department

The Chairman put forward a letter asking for suggestions concerning the introduction of a piece-work system into the fettling department of a shop making light castings.

Mr. Pedder suggested that the problem was one of dividing the castings into suitable units. If one divided them into groups according to their weight or according to the area to be fettled, and determined how many should be fettled in an hour, a piece-work rate could be arrived at which would enable the men to earn up to perhaps double their ordinary rate.

The Chairman suggested that the foreman might be asked to fettle a definite number of castings, and should be given all the help he required, and a basic rate should be established on the time taken to fettle those castings. It might work out at 1s. 6d., for example. If a workman could fettle the number of castings fettled by the foreman in double the time occupied by the foreman, he should be paid the basic rate, but if he could fettle at the same rate as the foreman had fettled, he should get double time.

Mr. Coupe said he had tried various methods of costing in the fettling shop, including the fixing of piece-work prices and the payment by bonus, but the cost of the clerical work, where a large variety of dissimilar articles were being handled, outweighed the benefits derived from the introduction of such systems.

Growth of Cast Iron

N. F. Vyasnikov in an article in "Liteynoye Dyelo," deals with the phenomenon of the "growth" of cast iron, or the permanent increase in volume which the metal undergoes when heated for a more or less considerable length of time at temperatures above 400 or 450 deg. C. The physical and chemical steps which have been proposed for preventing the growth are also reviewed. Experiments have been made on the effect of the addition of alloying metals on the growth and the following conclusions are drawn from them:—A content of chromium considerably reduces the growth of cast iron, but with a content of more than 1 per cent. chromium (for a manganese content of 1 per cent. and a silicon content of 2 per cent.) the cast iron is white and cannot be worked. In the case of nickel cast iron, a variation in the nickel content from 0.6 to 1.8 per cent. has no appreciable effect on the growth of the cast iron when the latter is heated to 800 and 950 deg. C., but when the iron is heated to 650 deg. C. for 25 hours, an increase in the nickel content within the above-mentioned limits somewhat diminishes the growth of nickel cast iron. In the case of chromium-nickel cast iron with a chromium content of about 1.1 per cent. an increase in the nickel content increases the growth of the cast iron when the latter is heated to 800 and 950 deg. C. and diminishes the growth when the iron is heated to 650 deg. C. Maximum growth occurs with ordinary cast iron and nickel cast iron, the growth of nickel cast iron in the experimental conditions being always less than that of ordinary cast iron. Chromium-nickel cast iron (1.1 per cent. chromium and up to 1.8 per cent. nickel) when heated five times for five hours, each time from 20 to 650 deg. C., gives a reduction in volume, while chromium cast iron (0.8 per cent. chromium) and a cast iron containing 2.72 per cent. chromium and 0.76 per cent. nickel do not change in dimensions under these conditions.

Company Meeting Report

General Refractories, Limited

(MANUFACTURERS OF HEAT-RESISTING AND HEAT-INSULATING MATERIALS, SHEFFIELD)

ANOTHER YEAR OF RECORD PROGRESS AND PROFITS—PRODUCTS IN EVER-INCREASING DEMAND

MR. FRANK S. RUSSELL'S SPEECH

The thirty-seventh annual general meeting of General Refractories, Limited, was held on Wednesday, March 31, in Sheffield. MR. FRANK S. RUSSELL (the chairman) presided.

The CHAIRMAN said that the year under review had been one of continued expansion, enlarged output, and increased employment, the latter being a cause of considerable satisfaction to the board. The annual growth of the figures of the wages lists of the group was rather impressive, and he was very glad that the improvement in trade, which had followed the wise and brilliant policy of the National Government, had permitted the company to increase the number of its employees, and thereby ensure comfort and happiness to many households in which care and penury had previously existed. During the year the internal organisation had been strengthened and a portion of the selling arrangements had been decentralised into branch offices under efficient managers.

After offering thanks to his co-directors, the staff and the employees generally for their co-operation, and announcing the establishment of a pension fund—to which the company had contributed £5,000—he said: When we met here last year I said I trusted we should meet again 12 months later to celebrate still another record year. This hope has been fulfilled, and, as you will have noted from the report, our sales in the year are more than half as much again as they were in the previous year, and our profit is far in advance of any figure it has ever reached before. Our own operations alone, without dividends, on our holding of ordinary shares in subsidiary companies, yielded us £66,741, as against the £55,392 realised in 1935, and which was the total of our own earnings added to the dividends mentioned.

The Genefax Group is now a very substantial combination for producing both refractories and profits. A close estimate of the gross profits earned by the other members of the group during last year (apart from our own) is in the neighbourhood of £79,000, subject to interest charges of about £9,000 and depreciation allocations totalling possibly £10,000. To the substantial bulk of the balance we are entitled by virtue of the proportion of the shares we hold, added to which there is, of course, an accumulation of substantial value standing to the credit of profit and loss accounts.

Final Dividend

The board recommends the payment of a final dividend of 10 per cent. (less income tax), making, with the interim dividend of 6 per cent. (less tax) paid on August 17 last, 16 per cent. for the year (as against 15 per cent. for last year).

In order to save expense and trouble it is intended to post the dividend warrants along with this report and the provisional allotments of the new share capital, if the issue of the latter be sanctioned at the meeting which follows.

Consolidated Accounts of the Subsidiary Companies

Instructions have been given to our auditors to prepare a consolidated balance-sheet as at March 31 from the accounts of the subsidiary companies which are being made up to that date, and this we hope to include with the progress report we intend to distribute early in August next along with the interim dividend.

This non-inclusion of the subsidiary dividends in current year's profits means that we can now always have a year of their dividends in hand. These provide a fund from which our own interim dividend can be paid and, in addition, the new system leaves plenty of time in which to prepare the accounts of the subsidiaries, hold their meetings and declare their dividends—a strong and conservative position which I know you will approve. We look forward with considerable confidence to the combined profits of the other members of the group being well in excess of our own, and feel we are entitled to expect this in return for our extension, improvement and reorganisation of their means of production.

On the advice of eminent accountants we are placing the audits of our principal English subsidiaries in the hands of our own auditors, and the Scottish audits in the hands of one firm of high standing there.

The Accounts

Turning to the accounts, there seems to be little for me to say because of the simple form in which they are presented. The capital was increased to £475,000, and has fully justified itself. The creditors are higher, but the debtors are proportionately higher still.

The total reserves are now within measurable distance of the total of the issued capital and may be equal to it next year. The credit balance carried forward to next year is only £8,000 less than it was last year, though this year's profits do not include the dividends I have mentioned, and we have put £3,000 more to income-tax reserve, £1,000 more to depreciation reserve, and have paid and are paying out in dividends nearly £20,000 more than last year. The value of our assets in the way of land, buildings, plant, etc., at cost, is £70,000 more than it was last year, and our holdings in other companies are worth £220,000 more than they were. Our stock-in-trade is higher by £25,000, and as against our creditor accounts of not more than £200,000 (including taxation) we have assets of over £1,000,000. The value of our stocks of raw materials has increased considerably since we acquired them.

National Value of Heavier Stocks of Imported Materials

With regard to this matter of stocks, it is our intention (for which we have already made arrangements) still further to increase the size of these stocks in order that our group may, in the event of a serious European disturbance, be independent of foreign supplies for many months to come. This is a measure of wise precaution which constitutes "preparedness" in accord with national policy, and works hand in hand with the National Rearmament Programme. As the cost of these materials is high, there is a considerable sum involved in financing them, and it is partly for this purpose that our new issue of capital is being made.

The country learned a lesson about stocks in 1914, and here I would emphasise to all parties concerned, the value in any time of National emergency of a group such as our own, under one control, **with its productive resources expanded, strengthened, and mechanised during times of peace and prosperity, ready for the worst that may happen,** whether it be the "rainy day" which many recent speakers appear to regard as inevitable, or an international conflict.

"How Long Will It Last?"

In mentioning the idea of a "rainy day" and being prepared for it, I am inevitably reminded of the "how-long-will-it-last" query, which seems to epitomise the attitude of some who sit in high places. I have long pondered over the reason for this, and have, after protracted thought, arrived at the conclusion that such speakers and writers were so much impressed by the not-far-distant slump from which we have now happily emerged, that they began to regard it as a normal state of affairs, and are at this moment timorously counting the hours that it seems to them must elapse before they are once again plunged into despair. I cannot find that this pessimism is in any way justified. Looking back at figures extending over many long years of the past, I do not find the slump conditions of 1930, 1931 and 1932 to be normal at all, but, on the other hand, definitely abnormal, and I see no reason why (rearmament or no rearmament) we cannot, with the added wisdom that our sufferings have taught us, continue indefinitely with that steady yet progressive "going on" which was accepted to be our due in Victorian years. What is known as "Prosperity" can easily be defined by such people as ourselves to mean "a demand for our goods." That demand arises from a demand for the goods of the consumer of our own products. That demand in its turn arises from other demands which can be shown to be born ultimately of a feeling of confidence in the future on the part of those with money to spend. This means that when those who hold the money bags are willing to adventure their wealth, there is a larger demand for our products, our overheads cease to absorb the profits, and we become "prosperous." Because of the fact that they risk so much to gain so little, it is obvious that the inhabitants of the world of finance must necessarily be cautious, not to say timid, in their whole outlook. A breath of wind will ruffle the financial sea, and it is only when those who navigate it feel certain that there is a reasonable expectation of calm weather that they will launch their golden argosies upon its somewhat treacherous bosom. It is important that their apprehensions be not aroused needlessly.

"There is Nothing to Fear but Fear Itself"

The man who asks how long it will last is showing fear and thus tending to undermine confidence. "Good trade" is nothing more or less than the result of our being willing to spend our money because we feel reasonable confidence that conditions will be such as to permit us to earn some more money to take the place of what we spend—just the contrary to the thought that we must not indulge in cake for fear the money might be wanted for bread—in a phrase, "Prosperity is the daughter of Confidence."

The vast national expenditure on armaments cannot do other than create confidence. Armaments cannot be made without refractories (and neither can war), so for this industry at least it would seem that the future holds nothing in the way of cause for immediate despondency.

Million Sales

For the ensuing twelve months, we have set our hearts and minds on achieving the sale of a million pounds' worth of goods, and I see no reason why we should not succeed—in fact, I feel very certain that we shall do so, as our sales organisation is being strengthened and extended, our existing branch offices will have got better into their strides, new ones (Birmingham, Middlesbrough and Cardiff) are being put into commission, many of the works are being extended and their output increased, the demand continues unabated and is increasing, and the strength we derive from our combination grows daily more apparent in the way in which the large contracts tend to gravitate to our group.

I am looking forward with confidence to being able, at the silver jubilee celebration banquet, which the company intends to offer to its staff on April 1 next year, to make the announcement that this one more milestone has been passed. We increased our sales by nearly a quarter of a million pounds this year, and expect to achieve a still more important increase in 1937.

Records and Statistics.—A Measure of Progress During Recent Years.

At date of report of	1934.	1935.	1936.
The number of Shareholders was	1,409	2,037	3,002
With an average Shareholding of	327	328	344
The Group's Annual Output Capacity of Firebricks of all kinds, in millions	23	47	87
The number of Works, Mines and Quarries, etc., in the Group ..	41	68	105
Group Expenditure on Railway Carriage during the year	£73,246	£102,330	£142,769

The number of super refractory bricks, such as magnesite, diazite, saxpyre and spinella, produced during the year at our now entirely mechanised model works at Worksop (probably the best equipped of its kind in Europe) was 41 per cent. greater than in 1935, which latter was 33 per cent. above 1934, which was 27 per cent. above 1933, which was 35 per cent. over 1932.

During the year the productive capacity of these works, which has been severely strained to keep pace with the demand, has been doubled, and they

are now being additionally equipped by a hydraulic press at least equal to the most powerful in Europe, and certainly the most modern.

Record outputs of high-grade refractory bricks of quality still further improved are expected to follow.

New Products

In the sales of new products the year has been chiefly remarkable for the increase in the output of "Saxpyre" bricks, which have definitely proved their value and reliability for use in basic open-hearth furnaces, and have been sold in increasingly large quantities both in Great Britain and on the Continent.

The knowledge gained in the evolution of this brick has led to a close study of the whole question of "spalling" (by which is meant the destruction of the brick as a result of its surface peeling and cracking and flying off following exposure to heat). Its causes have been investigated and its cure discovered, and as a result we have placed on the market the non-spalling

"Spinella Brick"

a compound of the spinels of magnesia, chromite, and alumina. The brick has successfully met the competition of a Continental brick of the same type which has made a certain amount of headway in this country in recent years, and those who have tried it report its superiority in every respect. There is an immense future before this type of brick, and we look forward to selling it freely in this country and abroad.

The Dolomax Brick—A Brick Based on British Dolomite

Some two years ago we produced a basic brick consisting almost entirely of dolomite, a highly refractory mineral which may be freely obtained in our own country, but which has ordinarily the defect of being subject to hydration. We evolved processes for its partial or complete stabilisation, but the demand for this class of brick being then uncertain, we did not put it on the market. Now, however, that so much interest is being shown in refractories which tend to render us independent of imported goods, we have done so, and with very encouraging results indeed.

We are pressing this introduction intensively, and though we are convinced that the field of application of any brick based on dolomite is limited, we shall explore that field to the fullest possible extent.

Export Trade

From time to time during the year British commercial leaders (and particularly Lord Riverdale) have emphasised the importance of this country developing its sales overseas (despite the intense home demand), because of its dependence upon imported foodstuffs. To this point of view we have fully subscribed, and we have by such means as are within our power developed our sales abroad.

The sales of this department of our business were, during the year, greatly in excess of those of the previous year, and arrangements we have completed point to a considerable further expansion during the current year, the sales for the month of February, for example, being twice those of February, 1936.

Our group is now building up a large export trade, based entirely on high quality, but so efficient are our processes becoming that we have little difficulty in competing in point of price also.

Insulation Against Heat Losses—The Easiest Way of Saving Money

You will recollect the formation of International Diatomite, Limited, and its issue being subscribed 16 times over. You will remember also that it acquired the majority shares in Moler Products, Limited, and that we were to transfer the manufacture of our own Diatomite Heat Insulating bricks to the Colchester Works of the last-named and take over from them the manufacture of refractory insulating bricks and the sales of both classes of bricks.

This has been duly effected, the whole of the selling arrangements have been rearranged, and the new sales campaign is in full swing.

The protection of furnace brickwork against the loss of heat is becoming every day more and more a matter of course, and the whole subject is becoming better understood.

Every shareholder can help in spreading the knowledge of the value of heat insulation, because of its universal application, an application which includes houses, shops, flats, refrigerators, firebacks, ovens, kilns, furnaces, and boilers, because Insulite and Economite bricks resist the passage of heat and keep it out just as well as they keep it in.

Progress of the Subsidiaries

The matter of their re-equipment and enlargement is being partially dealt with in the paragraph that follows, but you will be interested to hear that our Belgian works is now in full production on the execution of important orders, with a plant which is second to none of its type.

In our last progress report, I mentioned that one of our subsidiary companies was being enlarged to act as a holding company, to hold the shares of our subsidiary and associated companies. This has now been put into effect and the British Refractories Corporation, Limited, which has its own organisation under our own control, is already proving of considerable service in the simplification of the affairs with which we have to deal, and particularly in various types of joint action for the benefit of the group as a whole.

It is our ultimate aim to have only one subsidiary company whose accounts affect our own, and the arrangement whereby the year's dividends of the subsidiaries are being kept in hand is very helpful in this direction.

Company's Policy

In reviewing the position of our company, which is that of the controlling unit of a combine consisting of a matter of 35 companies, I would say a few words to those who seem from time to time to express a little fear lest our group become too large. I find that such thoughts emanate mainly from individualists whose own businesses have never expanded, but reviewing the combines whose names are household words to-day, both for their importance and for the success of their operations, and whose size pales our own to insignificance, I note "Allied Ironfounders" with a capital of over two and a half millions, "Associated Portland Cement Manufacturers" with six millions, "Calico Printers Association" with over five millions, "I.C.I." with 72 millions, "Lever Brothers" with 61 millions, "Radiation, Limited," with over three millions, and "Wall Paper Manufacturers" with over five millions. I feel we can safely follow where these and such as these have led.

Our own policy in this matter has been so successful (though only in its infancy) that it needs no defence, but in that fine organ of public opinion, the "Financial Times," I find a paragraph referring to rubber companies, headed "That blessed word amalgamation," from which I quote some extracts:—

> "What the boom did clearly demonstrate, was the needless labour and expense involved in there being such a multiplicity of companies, when, by a process of amalgamation, the industry could be so materially benefited and shareholders financially advantaged. The policy of amalgamation, to the 'common-or-garden' mind, seems no more than sensible and obvious. Why there should be scores of different companies, each of them paying London and other office expenses, and giving rise to innumerable difficulties . . . it is hard to understand."

This is precisely what we have done with a proportion of the British refractories industry, and we are now settling down to a policy of peaceful development of its interests, of exploitation of its mineral and other resources, and a general concentration, simplification and consolidation of its activities.

"General Refractories" and "Refractories Generally"

Almost from the first inception of the company it has been the aim and policy of those who control it to arrange that its name should be a true description of its functions and position, that is to say, that General Refractories shall deal in refractories generally, and not merely one section of that industry. This is a policy that has been steadily pursued for the last 24 years, by the addition of first one branch and then another branch of manufacture to the company's activities.

No one class of firebrick or type of refractory material works can meet the need of every section of users or every user, or be able to supply a consumer with all he requires.

Even during our earlier years our expansion was mainly in the direction of the acquirement of interests in existing plants, and we have always been averse to the idea of entering a field in direct competition to those already existing in it.

We are now heavily interested in the exceedingly important firebrick industries of Scotland and Stourbridge. We have acquired almost inexhaustible reserves of high-grade fireclay in both areas. It would have been easy for us to have erected extensive modern works near them, but we preferred rather to take the line of least resistance and enter the field by the purchase of existing interests, as, for instance, Glenboig, Turnbulls, Castlecary, and Stevens.

World-Renowned "Glenboig" Firebricks

Another advantage of this policy is that we thus acquire an existing connection and perhaps (as in the case of Glenboig) a brand held in high respect throughout the entire world.

Our expansion cannot be complete until our organisation is rounded off, and by our control of a supply of refractories of every known type and for every industrial purpose, and there are still left a few departments with which we are not closely enough in touch (notably glass, cement, and refractory holloware) and with which we must make alliances and provision therefore in our capital structure.

The Central Laboratory

Research is so essential a feature of our industry, which must ever be in advance of the needs of its customers, that there is no need for me to emphasise the advisability of our being second to none in Europe in our scientific equipment. Nothing will give our customers more confidence than this decision.

Silica Bricks—Famous "Lowood" and "Meltham" Brand

The shortage of scrap iron makes the use of more pig-iron imperative. To produce pig-iron it is necessary to consume coke, and coke means coke ovens. The output of the famous Meltham Silica Bricks must therefore be expanded to help the country's rearmament programme (if for no other reason), and at the Lowood Works, where the insistent demand (based entirely on the quality of the brick produced from the unique Deepcar Black Ganister) calls for an output at least twice that of the past, the output is being doubled by ultra-modern plant.

We have undertaken to supply "Refractories generally." We have secured an alliance with the makers of many of the best-known and most highly trusted brands, and we cannot sit with folded hands and say to our customers "Our output is limited to so much, and you must go elsewhere for the rest." This would be not only unpatriotic, but in direct contrast to our policy, which has not been unsuccessful through the years, and we cannot consider its adoption, nor do we think that our shareholders would wish us to do so.

The New Issue of Shares

All this, however, costs money, but so long as the money can be fully and adequately employed and earn a remunerative rate of return, this again is what the country needs to provide employment and prosperity.

This has a direct bearing on the meeting which follows, and whose purpose it is to authorise the increase in the company's capital. We have thought it wise, while conditions are favourable, so to equip ourselves financially, that we may be in a strong position of independence, that we may be able to meet the conditions which may arise in less prosperous times, and moreover, so to fortify our position (and that of your capital) that we may be able to resist all attacks upon it by way of either new refractories or new combinations of interest.

The Outlook

With regard to the future, I have learned not to pretend to be a prophet, and I am not prophesying now, but I do think that the extent to which new methods, reorganisation, modern machinery, and labour- and fuel-saving plant can increase earning capability is hardly thoroughly realised even by ourselves, nor the advantages we gain through our interests covering every field of our industry.

Our sales for the month of March are nearly twice those of last March. For much of our output of the cheaper grades of refractories we are obtaining a sorely-needed advance in price. We shall have an increasing output to sell, and, on the whole, I shall be surprised if 1937 does not yield results very gratifying to all concerned.

I think that, between us, we have built up something with a high-survival value, something based on a sound economic plan, and something worthy to endure through the years that are to come.

The report and accounts were adopted, and at the extraordinary general meeting which followed, the resolution to increase the capital by the creation and issue of a further 300,000 ten shilling ordinary shares was carried unanimously.

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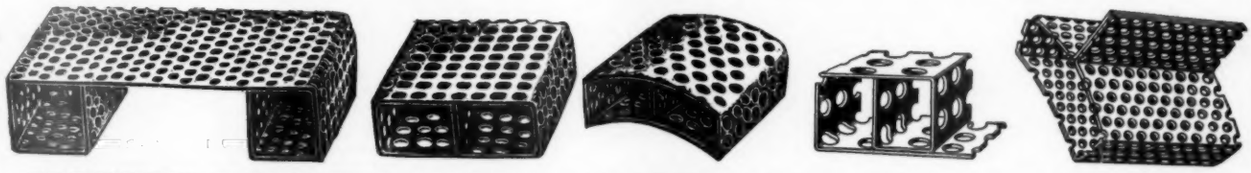

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- Low Carbon Malleable (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

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TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

● **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO. LTD. MIDDLESBROUGH

The Week's News in Brief

Trade Talk

THE RIVET, BOLT & NUT COMPANY, LIMITED, is to extend its plant at Gateshead-on-Tyne.

THE ACHEMA VIII CHEMICAL ENGINEERING EXHIBITION will be held in Frankfurt-on-Main from July 1 to 6.

A 400-TON ironstone excavator at the pits of the Cranford Ironstone Company, Limited, Cranford, Northants, was damaged by a sudden fall of earth.

GLASGOW RAILWAY ENGINEERING COMPANY, LIMITED, has received an order from the Bengal-Nagpur Railway Company for the supply of sixty pairs of 2 ft. 6 in. gauge wheels and axles.

WILLIAM DOXFORD & SONS, LIMITED, Sunderland, have received an order for two 9,200-ton motor vessels for the West Hartlepool Steam Navigation Company, Limited. The engines will also be built by Doxford's.

AVELING-BARFORD, LIMITED, of Grantham, have received a substantial Government contract. It is anticipated that the orders in hand will keep the works busy for the next two years and additional men will have to be engaged.

FERGUSON BROS., LIMITED, Port Glasgow, have received an order from the Crown Agents for the Colonies for a twin-screw high-power towing and salvage vessel for service at Ceylon. The propelling machinery will be constructed by the builders.

STERLING FOUNDRY SPECIALTIES, LIMITED, have completed an extension to their works at Bedford which will give them an additional production space of 5,000 sq. ft. Further new equipment is being installed, mainly for the production of Sterling moulding boxes.

IMPERIAL CHEMICAL INDUSTRIES, LIMITED, are to erect a 13,000 sq. ft. warehouse on the Team Valley Trading Estate at Gateshead-on-Tyne. The building will be of light steel framework with 9-in. concrete brick walls, and there will be road and rail links with main lines of communication.

ALFRED HOLT & COMPANY, Liverpool, have placed an order with the Caledon Shipbuilding & Engineering Company, Limited, Dundee, for two 10,000-ton motor passenger and cargo liners. The vessels will be 475 ft. in length and the machinery will be built by Burmeister & Wain, Copenhagen.

THE ENGINEERING SHOP at the Thorncliffe Ironworks, Chapeltown, owned by Newton, Chambers & Company, Limited, was struck by lightning last Thursday week. The electrical department suffered the most damage, but the works have carried on as usual and there has been no loss of employment.

FLEMING & FERGUSON, LIMITED, Paisley, have secured an order from the Argentine Government for a high-powered Diesel electric suction dredger of special design. The vessel will be 220 ft. in length. The firm are also to build a rock lifting dredger of 2½ yds. bucket capacity for the Northern Ireland Government.

H. G. SOMMERFIELD, LIMITED, the London general foundry suppliers, is extending the manufacturing side of its business to the production of sand blast plants. The existing stores will remain at Somerstown Low Level, and present manufacturing activities will be moved to the new works to be equipped near the North Circular Road.

J. & H. SCHOFIELD, LIMITED, textile machinists, of Walker Mill, Coldwell Street, Rochdale, Lancashire, are to take over the business of Hacking & Company, Limited, loom-makers, Lord Street, Bury. It is the intention to continue the works under the name of Hacking & Company. It is intended to get the foundry into operation as soon as possible.

WILLIAM CUMMING & COMPANY, LIMITED, of Glasgow, Chesterfield, and elsewhere, have opened a London office at Sentinel House, Southampton Row, London, W.C.1. Mr. C. H. V. Wilson, who for the past sixteen years has acted as their Southern representative, will be in charge of this office. His previous position has now been filled by the appointment of Mr. E. A. Carlisle, of Sheffield.

HALL, RUSSELL & COMPANY, LIMITED, Aberdeen, have received an order from the Admiralty to build two boom defence vessels of the trawler type. The Admiralty have also placed a contract with Henry Robb, Limited, Leith, for two special service vessels of the 1937 programme. The machinery will be built by White's Marine Engineering Company, Limited, Hebburn-on-Tyne.

AN ORDER FOR TWO high-speed cargo liners, each with a carrying capacity of 2,150 tons, has been received by Swan, Hunter & Wigham Richardson, Limited, Wallsend, from the Ellerman Wilson Line, of Hull. The engines, which will be of the triple expansion type with superheated steam and working in conjunction with low-pressure turbines on the Bauer-Wach system, will be supplied by Swan, Hunter's.

THE TREASURY HAVE ISSUED, on the recommendation of the Import Duties Advisory Committee, an order providing for the addition to the Free List, with effect from April 1, 1937, of iron or steel, other than alloy steel, in the form of cut bars not exceeding 6 in. in length, 6 in. in width and 1¼ in. in thickness, and containing not more than 0.030 per cent. sulphur, and not more than 0.025 per cent. phosphorus.

THE COLTNESS IRON COMPANY, LIMITED, in co-operation with Imperial Chemical Industries, Limited, are making arrangements with a view to the erection of works in the Clyde area for the production of non-ferrous metal tubes for the shipbuilding, housing and general engineering trades. It is proposed to form a new company and it is hoped the erection of the works will be commenced at an early date. The anticipation is that employment will be given in the first instance to about 150 men.

POWER-HOUSE EQUIPMENT for a new distillery to be erected at Dumbarton will be supplied by the International Combustion Company, Limited. Blairs, Limited, of Glasgow, will provide the still-house plant and part of the copper tanks and copper equipment, the remainder of which will be supplied by the Aluminium Plant & Vessel Company, Limited, London. The latter concern will also provide the refrigerating equipment, and Babcock & Wilcox, Limited, Renfrew, will supply the fermenting and washing tanks. The steel work will be carried out by Redpath, Brown & Company, Limited, Glasgow.

Contracts Open

Blaengarw, April 5.—700 yds. of 6-in. dia. cast-iron pipes, for the Mid-Glamorgan Water Board. Thomas & Morgan & Partners, civil engineers, Pontypridd. (Fee £2 2s., returnable.)

Hertford, April 6.—3,900 yds. of 3-in. cast-iron mains, for the Rural District Council. D. Balfour & Sons, consulting engineers, 47, Victoria Street, Westminster, S.W.1. (Fee £2, returnable.)

Bridgwater, April 6.—Duplicate centrifugal pumps, each capable of lifting 72,000 g.p.h. against 60 ft. to 106 ft. heads, with crude oil engines, auxiliary engines, crane, compressors, motors, and sludge pump, for the Town Council. Sandford Fawcett & Partners, consulting engineers, 53, Victoria Street, S.W.1. (Fee £5 5s., returnable.)

Wallasey, April 13.—Steam-driven gas compressing machinery for the boosting of coal gas in connection with high-pressure system of distribution; tubular steam-raising plant to be coal-gas fired with automatic method of regulation and control, for the Corporation. The Borough Gas and Water Engineer, Gasworks, Wallasey.

Wellington, June 30.—Five-ton portable type, level luffing, travelling, electric wharf cranes, for the Otago Harbour Board. The Department of Overseas Trade. (Reference T. 2,343.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

British Bath Manufacturers' Association, Limited.—Capital, £100. Subscribers: W. R. Blair and J. Galbraith Sneddon, 145, St. Vincent Street, Glasgow.

British Electro Metallurgical Company, Limited.—Capital, £100,000. Directors: Sir Edmund Davis, 13, Lansdowne Road, London, W.11; W. H. Sneath, and R. C. Brown.

F. Dupre, Limited.—Capital, £50,000. To take over the business carried on by F. C. C. P. Dupre, and to carry on the business of metallurgists, iron and general ore merchants, etc. Subscribers: E. J. Burrows, 29, Lyndhurst Road, Highams Park, London, E.4; T. E. Bowyer.

Personal

MR. C. A. NOTLEY has been appointed secretary of the London Metal Exchange, in succession to the late Mr. S. H. Lambert.

SIR JOHN PRIESTMAN, who recently had a seizure, is making a good recovery, and last week celebrated his 82nd birthday.

A DINNER, PRESIDED OVER by Provost K. H. Ross, was given on March 26 in recognition of the honour of knighthood conferred upon Sir William Biggart Lang, a director of John Lang & Sons, Limited, of Johnstone.

MR. JOHN H. EVERY, the well-known foundry owner, of Lewes, has presented Bull House to the trustees of the Sussex Archæological Trust. This house was generally known as Tom Paine's house. Tom Paine is famous as the author of "The Age of Reason."

MR. J. R. W. ALEXANDER, M.A., LL.B., F.C.I.S., barrister-at-law, has resigned his position as secretary of the Institution on his appointment, with effect on June 21, as general manager of Associated Gas & Water Undertakings, Limited, and as general manager of the East Surrey Gas Company.

THE RT. HON. A. DUFF COOPER, Secretary of State for War, will speak on "The Psychology of the Army" at a public luncheon to be held on April 22, at the Princes' Restaurant, Piccadilly, London, W.1. The luncheon is one of a series organised by the National Institute of Industrial Psychology, Aldwych House, London, W.C.2.

Obituary

THE DEATH HAS OCCURRED, at the age of 81, of Mr. John S. Douglas, who was the last survivor of the firm of Robert Douglas & Son, Melville Lane Foundry, Montrose. He retired about three years ago, when the business closed down.

WE DEEPLY REGRET to announce the death of Mr. George Batty, which has occurred in Pennsylvania. Batty was a Sheffield University trained metallurgist who, after spending some time in the crucible steel trade, went over to the electric furnace method and was amongst the pioneers of that industry. Batty was courageous—he would tackle problems in steelmaking most metallurgists would cavil at. Some of the risks he took left some of us gaping with astonishment. In technical discussion, too, he would often risk his reputation by putting forward unorthodox views, but his unconventionality was usually in accord with sound practice and definitely advanced the art of steelmaking. Moreover, with the passage of time his views are meeting with ready acceptation. He had a ready wit and was a formidable opponent in debate. He was in the habit of sending a small donation each year to a social fund operating in connection with the London Branch of the Institute of British Foundrymen, which he invariably designated as being earmarked "for the purchase of panther sweat for the lads." His career so far as the foundry industry was concerned was, if our memory serves us correctly, started when he was appointed foundry manager to the National Steel Foundry Company at Leven shortly after the war. Later, he joined Mr. Melmoth, his brother-in-law, at Lake & Elliot's at Braintree. Later both went to America, where Batty quickly established himself as consultant to a group of steel foundry owners. The tall, gaunt figure of Batty, with his acid scarred cheek, will long be missed in foundry circles on both sides of the Atlantic.

Forthcoming Events

Institute of British Foundrymen

APRIL 3.

Lincolnshire Section:—Annual general meeting, at the Technical College, Monks Road, Lincoln, at 7 p.m.

Lancashire Branch:—Annual general meeting; Reports of the Sub-Committees on (1) Two Leaded Gunmetals and (2) Dimensional Tolerances, at the Engineers' Club, Albert Square, Manchester, at 3.30 p.m.

APRIL 7.

London Branch:—Annual general meeting; Short Paper Competition, at the Charing Cross Hotel, London, W.C.2, at 8 p.m.

For **"easy stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

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SOUTH WALES OFFICE: Metropole Chambers, Wind Street, Swansea. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. Hood-Williams.)

CARDIFF OFFICE: 17, Windsor Place, Cardiff. Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter.)

MIDDLESBROUGH OFFICE: Halifax Buildings, Exchange Place.
Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. C. Souness.)

★

Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

Raw Material Markets

In many cases, iron and steel makers have taken the opportunity of carrying out repair work over the Easter vacation, but operations were curtailed for as short a period as possible. The holiday at the consuming plants was generally of longer duration, and in this way makers were able to overtake some of the arrears of deliveries.

Pig-Iron

MIDDLESBROUGH.—There has been little cessation of deliveries over the holiday period, consumers being anxious to get all the iron they can. With outputs fully disposed of over several months ahead, makers are not in the position to accept further inquiries for deliveries within any fixed length of time. An advance in prices is generally expected to come into operation on June 1, and until the revised scale of charges is announced the transaction of new contracts must inevitably remain difficult. All available supplies are carefully distributed, and under the scheme whereby iron is despatched proportionately to consumers' requirements, most users are able to continue operations satisfactorily.

Increases in the price of hematite are also anticipated in view of the higher quotations for raw material. Meanwhile, home business is conducted on the official minimum rates of 97s. 6d. per ton for East Coast mixed numbers, delivered on the North-East Coast, 103s. in Sheffield, and 108s. 6d. in the Midlands. Export trading naturally is restricted, but shipments have been on a better scale in recent weeks.

LANCASHIRE.—A substantial amount of new business is offering in this area, but producers generally are fully contracted over several months. For delivery to users in the Lancashire price zone, offers of Staffordshire and Derbyshire brands of No. 3 foundry iron are on the basis of 89s., with Northants at 87s. 6d. and Derbyshire forge iron at from 84s. to 86s., according to the class of user. Prices of hematite are nominal; West Coast material is quoted at 106s. and East Coast iron at 105s. 6d., both less 5s. rebate. For delivery equal to Manchester, Scottish foundry iron is quoted at 106s. per ton. Supplies of all grades are extremely difficult to secure.

MIDLANDS.—New business in this area appears to be confined solely to the renewal of expired contracts, whenever this is possible. There has been an increase in delivery specifications and many users are handicapped by the lack of material. Northants No. 3 iron is quoted at 83s. 6d., with Derbyshire, Lincolnshire and North Staffordshire at 86s., including delivery to Birmingham and Black Country stations. In view of the shortage of the cheaper grades of pig-iron, the demand for the special irons is steadily increasing. There is a fairly good supply of low-phosphorus material at from £5 5s. to £5 15s. per ton, but it is difficult to obtain medium-phosphorus iron in parcels of any size. The price of the latter is £4 10s. to £5 and is for material of from 0.75 per cent. to 1 per cent. phosphorus. Refined iron, at £6 17s. 6d. and upwards, is usually readily acquired. For delivery to Birmingham and district, West Coast mixed numbers are quoted at £5 9s. 6d., East Coast No. 3 at £5 8s. 6d. and Welsh mixed numbers at £5 8s. Supplies are very scarce and it is now increasingly difficult to renew old contracts, although makers are endeavouring to maintain a close contact with old and valued customers.

SCOTLAND.—Producers are severely tested in order to keep deliveries on a satisfactory scale, and no new business can be entertained. No. 3 foundry iron continues to be quoted at 88s., with 2s. 6d. extra for No. 1. No. 3 Cleveland iron is quoted at 84s. per ton f.o.t. Falkirk and 87s. f.o.t. Glasgow, but, in view of the shortage of supplies, these figures are purely nominal. Steel-making irons are hard to obtain. Mixed numbers of hematite are quoted at 98s., and basic, British and Indian, at 82s. 6d., f.o.t. steelworks, both subject to 5s. per ton rebate.

Coke

Prices on the foundry-coke market are very firm and display a rising tendency. For delivery to Birmingham and district, prices on and after to-day (Thursday) will be 46s. 6d., minimum, for best Durham coke and 47s. 6d. per ton and upwards for Welsh coke.

Steel

New business in steel is very difficult to negotiate, as producers have fully disposed of their outputs over a long period ahead. Further, tonnages of imported material are only small and do not give much relief to the insistent inquiries which are being received from day to day. Makers have found it hard to maintain deliveries according to schedule in many cases. Under present conditions the export market bears a neglected appearance, but producers are anxious to maintain contact with overseas consumers.

Scrap

There is still a lack of information regarding selling prices of scrap, and business in the meantime is restricted. Merchants in the Cleveland area are unwilling to enter into contracts for the supply of heavy melting steel at 67s. per ton, which figure is freely offered. As high as 85s. is offered for supplies of good machinery metal, but this material is also scarce. Clean light cast iron is now quoted at 72s. 6d. per ton. No relief is noticeable in the supply position in South Wales, and business is restricted to small parcels. Prices are firm. Similar conditions prevail in the Midlands, where prices are firm at recent levels. All qualities receive a good inquiry in Scotland, and it is evident that the recently-introduced scheme of control is operating there with more effect. Some improvement is expected when large consignments of imported material arrive. Both steelworks and ironworks are in the market for heavy tonnages.

Metals

The London Metal Exchange closed for the Easter holiday after the morning session on Thursday and reopened on Tuesday. Markets generally have been firm and conditions were active right up to the final trading period before the vacation. Usually business is quiet in the days immediately preceding a break. On the resumption on Tuesday the markets were somewhat dull.

Copper.—This market continues to be sound, and consumption is quite satisfactory. Further strength was noticeable following the receipt of more reassuring news regarding the labour situation in the United States, where industry is taking up substantial tonnages. The domestic price of copper in the States has been raised to 17c. per lb., New York.

Metal Exchange quotations were as follow :—

Cash.—Wednesday, £72 2s. 6d. to £72 10s.; Thursday, £73 7s. 6d. to £73 10s.; Tuesday, £73 to £73 5s.; Wednesday, £72 17s. 6d. to £73.

Three Months.—Wednesday, £71 13s. 9d. to £71 15s.; Thursday, £72 13s. 9d. to £72 15s.; Tuesday, £72 2s. 6d. to £72 5s.; Wednesday, £72 6s. 3d. to £72 7s. 6d.

Tin.—Uncertain conditions continue to prevail in this metal from all aspects, and the March statistics appear further to have unsettled the market. Supplies are short and there is little prospect of any relief in the situation. At the same time deliveries to the United States remain on a good scale. Large tonnages of tin continue to be received in this country from Dutch producers. The March issue of the Statistical Bulletin published by the International Tin Research and Development Council reveals that world consumption of tin in January, 1937, increased by 18.4 per cent., to 15,668 tons, as compared with 13,237 tons in January, 1936. At 311,000 tons, world tinplate production in January, 1937, compares with 275,000 tons in the corresponding period of 1936. World production of tin in the first month of the current year was 13,660 tons, against a similar figure in the corresponding month of last year. In the year ended January, 1937, the consumption of tin in the United States increased by 19.5 per cent., compared with the previous year, but in the United Kingdom the increase was only 1.8 per cent. Consumption in Russia increased by 30.6 per cent., and in France by 21.9 per cent., while other notable increases were recorded in the instances of Czecho-Slovakia, 38.5 per cent., Belgium, 28.2 per cent., Poland, 42.1 per cent., and Japan, 18.8 per cent. Chief decreases were recorded in Germany (18.5 per cent.), Sweden (17.4 per cent.), and India (9.4 per cent.).

Metal Exchange quotations were as follow :—

Cash.—Wednesday, £298 to £299; Thursday, £302 to £303; Tuesday, £293 10s. to £294; Wednesday, £294 to £294 10s.

Three Months.—Wednesday, £289 5s. to £289 10s.; Thursday, £293 to £293 10s.; Tuesday, £288 5s. to £288 15s.; Wednesday, £290 to £290 10s.

Spelter.—Substantial tonnages have been taken up in recent transactions, and the firm tone of the market has been well maintained. There is still cause for considerable anxiety as far as the supply position is concerned, as the tonnage available on the open market is not great, especially of high-grade metal. Higher quotations would appear to be imminent.

Official quotations were as follow :—

Ordinary.—Wednesday, £33 12s. 6d.; Thursday, £33 11s. 3d.; Tuesday, £33 15s.; Wednesday, £33 12s. 6d.

Lead.—An improvement has been brought about in the supply position of this metal, and fears of a shortage have been temporarily allayed. In the United States, conditions have become quieter following a period of heavy buying. Consumers are generally well covered. As a result, the price has declined to 6.95 cents per lb., New York.

Day-to-day quotations :—

Soft Foreign (Prompt).—Wednesday, £31 17s. 6d.; Thursday, £31 15s.; Tuesday, £31 18s. 9d.; Wednesday, £31 16s. 3d.

Company Reports

G. D. Peters & Company, Limited.—Net profit for 1936 of £21,912.

Worthington-Simpson, Limited.—Dividend of 7 per cent. for the year to December 31.

Associated Electrical Industries, Limited.—Dividend of 10 per cent. on the ordinary stock for 1936.

Manganese Bronze & Brass Company, Limited.—Final dividend of 10 per cent. on the ordinary shares.

Morgan Crucible Company, Limited.—Net profit for 1936, £417,892; final dividend of 1s. per £1 of ordinary stock (making 1s. 6d. for the year).

General Refractories, Limited.—Profit for 1936, £66,741; interest charges and fees, £2,353; brought in, £20,983; interim dividend, £20,587; income tax reserve, £10,000; bad debts reserve, £1,000; depreciation reserve, £5,000; final dividend of 10 per cent., £36,219; carried forward, £12,565.

Vickers, Limited.—Profit for 1936, £1,619,243; income tax, debenture interest and other expenses, £456,633; to reserve, £250,000; dividends on the preference stocks for the year, £418,190; brought in, £241,608; dividend of 10 per cent. on the ordinary stock, £469,528; carried forward, £266,500. Meeting, April 2.

Thos. Firth & John Brown, Limited.—Profit for 1936, £651,644; brought in, £69,200; debenture and mortgage interest, £49,111; depreciation, £92,000; income tax, £120,000; preference dividend, £48,300; interim dividend on the ordinary shares of 5 per cent., free of tax, £77,500; final dividend of 10 per cent., free of tax, £155,000; to general reserve, £100,000; carried forward, £78,934.

Guest Keen Baldwins Iron & Steel Company, Limited.—Profit for 1936, before charging interest, £399,696; special depreciation, £50,000; interest on temporary loans, less interest receivable, £2,385; interest on 4 per cent. first mortgage debenture stock, £90,000; interest at 5 per cent. on income notes, £28,950; required for part redemption of income notes for year, £7,411; brought in, £41,106; to contingencies account, £50,000; dividend of 6 per cent. on the redeemable cumulative preference shares, £59,555; dividend of 2½ per cent. on the ordinary shares for the year, £70,055; carried forward, £82,446.

Enamellers' Visit to America Postponed

Owing to the incidence of the Coronation and the extreme pressure of business, it has been decided to postpone the proposed visit to America of The Institute of Vitreous Enamellers until 1938. The members and officers are deeply appreciative of the cordiality of the invitation they have received from the American enamellers, and the readiness shown to fall in with their wishes.

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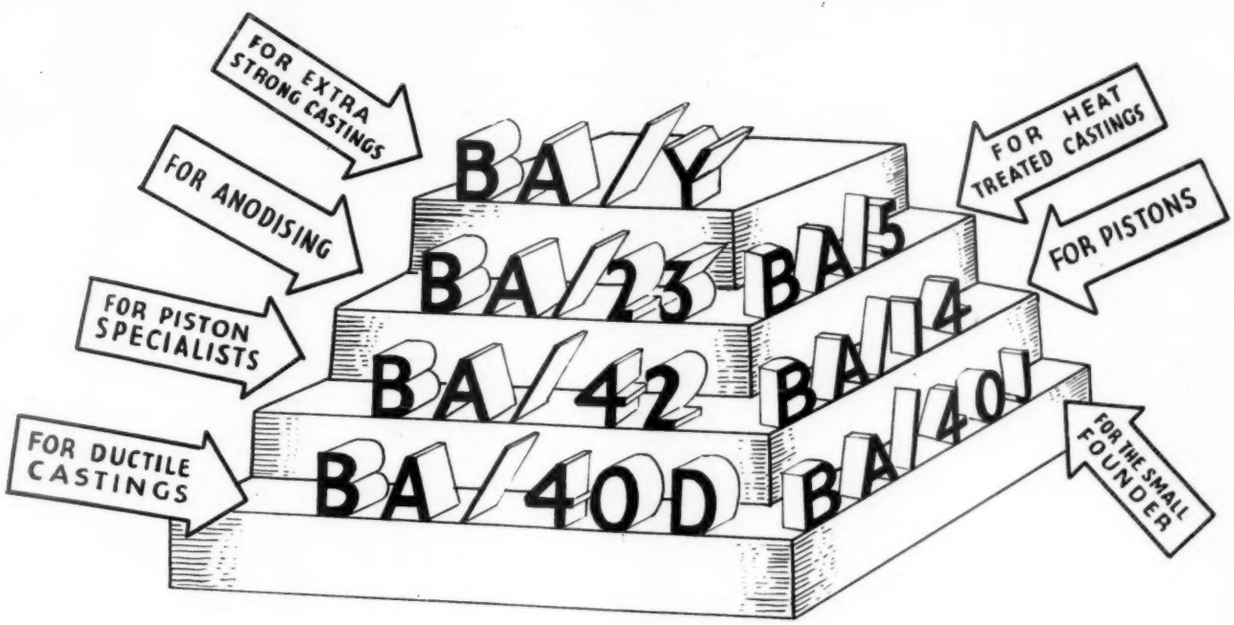

B.A. "Y."

"Y" alloy is one of the few good things that came out of the Great War. "B.A." Alloy is a thoroughbred version produced under the best conditions of mixing and melting, which sets a challenging standard of quality.

B.A. 23.

In B.A. 23 you have all the advantages conferred by magnesium silicide; high strength on heat-treatment, high corrosion resistance and a clear silver anodic film in an alloy which can be cast.

B.A. 5.

Heat-treatment has come to stay and No 5 alloy is probably the cheapest and simplest heat-treatable alloy available. It is widely used where stiffness at elevated temperatures is needed.

B.A. 42.

This alloy has a very low expansion and can be heat-treated to give as hard a piston as has yet been cast.

B.A. 14.

A piston alloy of great merit, its technical advance on 2L8 is instanced by the fact that it gives 60% higher Brinell hardness after simple heat-treatment.

B.A. 40 D.

This well-known alloy can be recommended for malleability, resistance to corrosion, fluidity in intricate moulds and for all castings designed to withstand hydraulic pressure.

B.A. 40 J.

This is an alloy of the same class as 40 D but contains less silicon and is used without modification. It is very fluid and can be recommended to the small founder for thin intricate work.

THE
British Aluminium
CO. LTD

Head Office:
ADELAIDE HOUSE, LONDON, E.C.4. **Phone: Mansion House 5561 & 8074.** **Grams: "Cryolite, Bilgate, London."**

F.T.J. 1.4.37

RAW MATERIALS—PRICE LIST

(Wednesday, March 31, 1937)

COPPER

	£ s. d.
Standard cash	72 17 6
Three months	72 6 3
Electrolytic	78 0 0
Tough	78 5 0
Best selected	78 15 0
Sheets	108 0 0
India	89 10 0
Wire bars	80 0 0
Ingot bars	81 0 0
H.C. wire rods	83 10 0
Off. av. cash, Feb.	59 5 6
Do., 3 mths., Feb.	59 6 9
Do., Sttlmnt., Feb.	59 5 3
Do., Electro, Feb.	64 11 10½
Do., B.S., Feb.	64 13 9
Do., wire bars, Feb.	65 3 6
Solid drawn tubes	15½d.
Brazed tubes	15¾d.
Wire	11½d.

BRASS

Solid drawn tubes	14d.
Brazed tubes	16d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	11¾d.
Wire	11½d.
Rolled metal	11½d.
Yellow metal rods	8½d.

TIN

	£ s. d.
Standard cash	294 0 0
Three months	290 0 0
English	294 10 0
Bars	296 10 0
Straits	294 10 0
Australian	—
Eastern	288 5 0
Banca	294 10 0
Off. av. cash, Feb.	233 19 7½
Do., 3 mths., Feb.	234 16 8½
Do., Sttlmt., Feb.	233 19 6

SPELTER

	£ s. d.
Ordinary	33 12 6
Remelted	33 0 0
Hard	30 15 0
Electro 99.9	36 3 9
English	35 0 0
India	31 10 0
Zinc dust	31 0 0
Zinc ashes	11 10 0
Off. aver., Feb.	25 4 5½
Aver. spot, Feb.	25 2 5¼

LEAD

	£ s. d.
Soft foreign, ppt.	31 16 3
Empire (nom.)	32 13 9
English	33 15 0
Off. aver., Feb.	28 6 2⅜
Aver. spot, Feb.	28 6 4½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	47 5 0 to 47 15 0
Do., V.M. ex-whse.	47 5 0 to 47 15 0
Rods	51 0 0

ANTIMONY

	£ s. d.
English	88 0 0 to 89 0 0
Chinese, ex-whse.	77 10 0
Crude, c.i.f.	43 0 0

QUICKSILVER

	£ s. d.
Quicksilver	14 7 3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	9 5 0
45/50%	10 15 0 to 12 0 0
75%	15 15 0 to 17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	4/6 lb.
Tungsten metal powder—	
98/99%	4/7½ lb.
Ferro-chrome—	
2/4% car.	31 17 6
4/6% car.	21 10 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	32 10 0
Max. 1% car.	35 15 0
Max. 0.5% car.	36 10 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	7/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£13 15 0 to 14 5 0
76/80% packed	£14 15 0 to 15 5 0
76/80% export	£13 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales—	£ s. d.	£ s. d.
Heavy steel	3 8 0	to 3 10 0
Mixed iron and steel	3 5 0	to 3 7 6
Heavy cast iron	3 8 0	to 3 10 0
Good machinery	4 2 6	to 4 5 0

Cleveland—	
Heavy steel	3 7 0
Steel turnings	2 12 6
Heavy cast iron	4 2 6
Heavy machinery	4 5 0

Midlands—		
Short heavy steel	3 12 6	to 3 15 0
Light cast-iron scrap		3 5 0
Heavy wrought iron	3 17 6	to 4 2 6
Steel turnings		2 5 0

Scotland—		
Heavy steel	3 4 6	to 3 7 0
Ordinary cast iron	4 0 0	to 4 2 6
Cast-iron borings	2 0 0	to 2 2 6
Wrot-iron piling	4 0 0	to 4 1 3
Heavy machinery	4 6 3	to 4 7 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	58 0 0
Brass	35 0 0
Lead (less usual draft)	26 10 0
Tea lead	22 0 0
Zinc	18 0 0
New aluminium cuttings	75 0 0
Braziery copper	52 0 0
Gunmetal	57 0 0
Hollow pewter	190 0 0
Shaped black pewter	138 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	98/-*
Hematite M/Nos.	97/6*

N.W. Coast—	
Hem. M/Nos. d/d Glas.	98/-*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	135/-

Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-

Scotland—	
Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/-
Cleveland No. 3, Glasgow	87/-
,, ,, Falkirk	84/-
Scottish hem. M/Nos. d/d	98/-*

Sheffield (d/d district)—	
Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*

Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	106/-
Clyde, No. 3	106/-
Monkland, No. 3	106/-
Summerlee, No. 3	106/-
Eglinton, No. 3	106/-
Gartsherrie, No. 3	106/-
Shotts, No. 3	106/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	11 17 6	
Nut and bolt iron	10 5 0	to 10 15 0
Hoops	12 15 0	
Marked bars (Staffs) f.o.t.	14 7 6	
Gas strip	12 15 0	
Bolts and nuts, ¾ in. × 4 in.	17 10 0	and up.

Steel—	£ s. d.	£ s. d.
Plates, ship, etc.	9 10 6	to 9 13 0
Boiler plts	10 0 6	to 10 3 0
Chequer plts.	11 3 0	
Angles	9 3 0	
Tees	10 3 0	
Joists	9 3 0	
Rounds and squares, 3 in. to 5½ in.	10 3 0	
Rounds under 3 in. to ¼ in. (Untested)	9 10 0	
Flats—8 in. wide and over	9 8 0	
,, under 8 in. and over 5 in.	9 13 0	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 10 0	
Hoops (Staffs)	10 5 0	
Black sheets, 24g. (4-t. lots)	14 0 0	
Galv. cor. shts. (,,)	17 0 0	
Galv. flat shts. (,,)	17 10 0	
Galv. fencing wire, 8g. plain	16 0 0	
Billets, soft	6 5 0	
Sheet bars	6 2 6	to 6 10 0
Tin bars	6 2 6	to 6 10 0

PHOSPHOR BRONZE

	Per lb. basis
Strip	15d.
Sheet to 10 w.g.	16d.
Wire	16½d.
Rods	17d.
Tubes	21¼d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5 to 1/11
To 25 in. wide	1/5½ to 1/11½
Ingots for spoons and forks	1/6 to 2/-
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	1/1 to 1/9½
to 10g.	1/7½ to 2/2½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/6½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	20.50
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00

	Cents.
Iron bars, Chicago	—
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.15
Skelp, grooved steel	2.10
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	32/6 to 33/-
,, furnace	27/- to 28/-
Durham foundry	28/-
,, furnace	27/-
Scotland foundry	28/-
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	22/6 to 23/6
,,	28×20 ,,	45/- to 47/-
,,	20×10 ,,	30/6 to 31/-
C.W.	18¾×14 ,,	22/6 to 23/-
,,	20×14 ,,	17/9 to 18/9
,,	28×20 ,,	35/9 to 37/-
,,	20×10 ,,	25/6 to 26/-
,,	18¾×14 ,,	18/6 to 19/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12 0 0	to £13 0 0
Bars-hammered, basis	£18 10 0	to £20 0 0
Bars and nail-rods, rolled, basis	£17 10 0	to £18 10 0
Blooms	£14 0 0	to £14 10 0
Keg steel	£26 0 0	to £29 0 0
Faggot steel	£19 0 0	to £25 0 0
Bars and rods dead soft, st'l	£16 0 0	to £18 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Mar.	24	..	72	2	6	inc.	72/6
,,	25	..	73	7	6	,,	25/-
,,	30	..	73	0	0	dec.	7/6
,,	31	..	72	17	6	,,	2/6

Standard Tin (cash)

			£	s.	d.		
Mar.	24	..	298	0	0	inc.	260/-
,,	25	..	302	0	0	,,	80/-
,,	30	..	293	10	0	dec.	170/-
,,	31	..	294	0	0	inc.	10/-

Spelter (ordinary)

			£	s.	d.		
Mar.	24	..	33	12	6	inc.	60/-
,,	25	..	33	11	3	dec.	1/3
,,	30	..	33	15	0	inc.	3/9
,,	31	..	33	12	6	dec.	2/6

Lead (soft foreign, prompt)

			£	s.	d.		
Mar.	24	..	31	17	6	inc.	25/-
,,	25	..	31	15	0	dec.	2/6
,,	30	..	31	18	9	inc.	3/9
,,	31	..	31	16	3	dec.	2/6

Electrolytic Copper

			£	s.	d		
Mar.	24	..	78	0	0	inc.	80/-
,,	25	..	78	0	0	No change	
,,	30	..	78	0	0	,,	,,
,,	31	..	78	0	0	,,	,,

Tin (English ingots)

			£	s.	d.		
Mar.	24	..	298	0	0	inc.	260/-
,,	25	..	302	0	0	,,	80/-
,,	30	..	294	0	0	dec.	160/-
,,	31	..	294	10	0	inc.	10/-

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Mar.	24	..	36	3	9	inc.	58/9
,,	25	..	36	2	6	dec.	1/3
,,	30	..	36	6	3	inc.	3/9
,,	31	..	36	3	9	dec.	2/6

Lead (English)

			£	s.	d.		
Mar.	24	..	33	15	0	inc.	20/-
,,	25	..	33	15	0	No	change
,,	30	..	33	15	0	,,	,,
,,	31	..	33	15	0	,,	,,

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	48 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	58 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	45 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 3
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	86 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 6	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 3½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6
1933*	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6
1934*	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	66 10½
1935*	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	69 4½	70 0	67 10½
1936*	70 0	70 0	70 0	70 0	70 0	70 0	75 0	75 0	75 0	75 0	75 0	81 0	73 0
1937*	81 0	81 0	81 0	—	—	—	—	—	—	—	—	—	—

* Delivered Middlesbrough area. Prior to 1933, prices were f.o.t. furnaces.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON
REGISTERED TRADE MARK
CUMPAS

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

CUPOLA-FURNACEMAN, experienced and reliable, desires situation. Reference.—Box 318, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN, age 32, seeks change. Practical knowledge cupola, drawings, high-grade jobbing and moulding machine castings. Keen, energetic, competent.—Box 316, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN or Assistant desires change. Experienced jobbing, repetition, high-duty and ordinary cast irons. Young, keen and energetic. Guaranteed to get results.—Box 296, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN required for iron foundry in North-East Coast District to take complete charge under Works Manager. Must be accustomed to loam, dry and green sand work and machine moulding. Class of work includes special pipes up to largest sizes, and general engineering castings up to 6 tons weight. State age, experience in full, salary required, and when at liberty, to: Box 314, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

BRASS and Aluminium Foundry Foreman seeks re-engagement; over 20 years' practical experience; electrical, sanitary, valves and general engineering castings. (294)

DIE Casting Shop Manager seeks re-engagement; full control or as Assistant. Has been in charge of aluminium die casting foundry and all subsidiary processes. Well educated, technical training. (295)

YOUNG Foundryman, Technical College trained, Diploma, two First Class City and Guilds Certificates, Bronze Medal, desires situation as Assistant to Foundry Manager. Sound metallurgical, analytical and engineering training. Go anywhere. (296)

IRON and Steel Works Metallurgist desires change. Thorough experience all branches; analytical, metallurgical, heat-treatment, testing, pyrometry, etc. Practical steelmaking and rolling experience. (297)

PROPERTY

LARGE Iron-Ore Mine, near Banbury, with rail sidings. Face of ore 16 ft. deep and 2 ft. below the surface. To be Let on Lease. For further particulars apply: Messrs. Rawlence & Squarey, 4, The Sanctuary, Westminster Abbey, London, S.W.1.

TENDER

THE CHELTENHAM AND GLOUCESTER JOINT WATER BOARD.

TO CAST-IRON PIPE MANUFACTURERS.

Proposed 27-in. diameter Pumping Main from Stonehouse Farm to a Proposed Reservoir on Churchdown Hill, etc.

TENDERS are invited for the supply and delivery of either Cast-iron Pipes and/or Special Pipes, etc., for the above main.

Conditions of Contract, Specification, Bill of Quantities and Forms of Tender may be obtained from C. J. Scudamore, Esq., M.Inst.C.E., M.Inst.W.E., Joint Engineer, 21, Eastgate Street, Gloucester, on the payment of a deposit of Two Guineas, which will be refunded on receipt of a *bona fide* Tender (which has not been subsequently withdrawn).

Tenders, sealed and endorsed "Contract No. 1 (and/or Contract No. 1A), Tender for Cast-iron Pipes, etc.," must be received by the Joint Engineers at 21, Eastgate Street, Gloucester, not later than 12 Noon on Wednesday, April 14, 1937.

The lowest or any Tender will not necessarily be accepted.

G. GOULD MARSLAND,
B.Sc., M.Inst.C.E.,
C. J. SCUDAMORE,
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